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ECON INCORPORATED

VOLUME X

SEASAT ECONOMIC ASSESSMENT

THE SATIL 2 PROGRAM

A PROGRAM FOR THE EVALUATION OF THE COSTS OF AN OPERATIONAL SEASAT SYSTEM AS A FUNCTION OF OPERATIONAL REQUIREMENTS AND RELIABILITY

ECON INCORPORATED

Report No. 75-125-10B
NINE HUNDRED STATE ROAD
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609 924-8778

FINAL

VOLUME X

SEASAT ECONOMIC ASSESSMENT

THE SATIL 2 PROGRAM

A PROGRAM FOR THE EVALUATION OF THE COSTS OF AN OPERATIONAL SEASAT SYSTEM AS A FUNCTION OF OPERATIONAL REQUIREMENTS AND RELIABILITY

Prepared for

National Aeronautics and Space Administration
Washington, D. C.

Contract No. NASW-2558

August 31, 1975

NOTE OF TRANSMITTAL

The SEASAT Economic Assessment was performed for the Special Programs Division, Office of Applications, National Aeronautics and Space Administration, under contract NASW-2558. The work described in this report began in February 1974 and was completed in August 1975.

The economic studies were performed by a team consisting of Battelle Memorial Institute; the Canada Centre for Remote Sensing; ECON, Inc.; the Jet Propulsion Laboratory; and Ocean Data Systems, Inc. ECON, Inc. was responsible for the planning and management of the economic studies and for the development of the models used in the generalization of the results.

The SATIL 2 program has been developed to assist with the programmatic evaluation of alternative approaches to establishing and maintaining a specified mix of operational sensors on spacecraft in an operational SEASAT system. The program enables the assessment of the effects of operational requirements and reliability (spacecraft buses, sensors, and transportation systems) on the time phased costs of alternative approaches. The SATIL 2 program is specifically designed to allow for the explicit consideration of reliability and cost uncertainties. In order to perform this evaluation, the launch systems and spacecraft (buses and sensors) are considered in detail from the points of view of the major sub-systems reliability and costs. All costs are treated as uncertainty variables where ranges of possible values are considered as well as subjective estimates pertaining to the form of the uncertainty (the probability distribution) within the range. As a result, the program develops a set of probability distributions associated with costs and events (i.e., number of launch attempts, etc.) as functions of time and the probability distribution of the present value of total recurring costs. All of the results are based upon an optimization of the mix of sensors, spacecraft buses, and transportation systems and launch schedules in order to meet the sensor demand function.

Although the SATIL 2 program was developed to assist in the evaluation of the costs of operational SEASAT system alternatives, the program is general and can be used for the evaluation of the costs of any proposed geocentric satellite system.

The SEASAT Users Working Group (now Ocean Dynamics Subcommittee) chaired by Dr. John Apel of the National Oceanographic and Atmospheric Administration, served as a valuable source of information and a forum for the review of these studies.

Mr. S.W. McCandless, the SEASAT Program Manager, coordinated the activities of the many organizations that participated in these studies into the effective team that obtained the results described in this report.

The SATIL 2 mathematical model, its structure, and computational procedures were developed by Joel S. Greenberg who also authored this report. B.P. Miller assisted in the formulation of the problem and the structuring of the model. Programming was performed by Michael Silverman and Philip Abram implemented the linear programming algorithm.

B. P. Miller

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

1. OVERVIEW OF THE ASSESSMENT

This report, consisting of ten volumes, represents the results of the SEASAT Economic Assessment, as completed through August 31, 1975. The individual volumes in this report are:

Volume	I -	Summary and Conclusions
Volume	II -	The SEASAT System Description and Performance
Volume	III -	Offshore Oil and Natural Gas Industry - Case Study and Generalization
Volume	IV -	Ocean Mining - Case Study and Generalization
Volume	V -	Coastal Zones - Case Study and Generalization
Volume	VI -	Arctic Operations - Case Study and Generalization
Volume	VII -	Marine Transportation - Case Study and Generalization
Volume	VIII -	Ocean Fishing - Case Study and Generalization
Volume	IX -	Ports and Harbors - Case Study and Generalization
Volume	X -	A Program for the Evaluation of Operational SEASAT System Costs.

Each volume is self-contained and fully documents the results in the study area corresponding to the title. Table 1.1 describes the content of each volume to aid readers in the selection of material that is of specific interest.

The SEASAT Economic Assessment began during Fiscal Year 1975. The objectives of the preliminary economic assessment, conducted during Fiscal Year 1975, were to identify the uses and users of the data that could be produced by an operational SEASAT system and to provide preliminary estimates of the benefits produced by the applications of this

Table 1.1: Content and Organization of the Final Report

Volume No.	Title	Content
I	Summary and Conclusions	A summary of benefits and costs, and a statement of the major findings of the assessment.
II	The SEASAT System Description and Performance	A discussion of user requirements, and the system concepts to satisfy these requirements are presented along with a preliminary analysis of the costs of those systems. A description of the plan for the SEASAT data utility studies and a discussion of the preliminary results of the simulation experiments conducted with the objective of quantifying the effects of SEASAT data on numerical forecasting.
III	Offshore Oil and Natural Gas Industry-Case Study and Generalization	The results of case studies which investigate the effects of forecast accuracy on offshore operations in the North Sea, the Celtic Sea, and the Gulf of Mexico are reported. A methodology for generalizing the results to other geographic regions of offshore oil and natural gas exploration and development is described along with an estimate of the worldwide benefits.
IV	Ocean Mining - Case Study and Generalization	The results of a study of the weather sensitive features of the near shore and deep water ocean mining industries are described. Problems with the evaluation of economic benefits for the deep water ocean mining industry are attributed to the relative immaturity and highly proprietary nature of the industry.

Table 1.1: Content and Organization of the Final Report (continued)

Volume No.	Title	Content
V	Coastal Zones - Case Study and General- ization	The study and generalization deal with the economic losses sustained in the U.S. coastal zones for the purpose of quantitatively establishing economic benefits as a conse- quence of improving the predictive quality of destructive phenomena in U.S. coastal zones. Improved prediction of hurricane landfall and improved experimental knowledge of hurricane seeding are discussed.
VI	Arctic Operations - Case Study and Generalization	The hypothetical development and transportation of Arctic oil and other resources by ice breaking super tanker to the continental East Coast are discussed. SEASAT data will contribute to a more effective transportation operation through the Arctic ice by reducing transportation costs as a consequence of reduced transit time per voyage.
VII	Marine Transportation- Case Study and General- ization	A discussion of the case studies of the potential use of SEASAT ocean condition data in the improved routing of dry cargo ships and tankers. Resulting forecasts could be useful in routing ships around storms, thereby reducing adverse weather damage, time loss, related operations costs, and occasional catastrophic losses.
VIII	Ocean Fishing - Case Study and Generaliz- ation	The potential application of SEASAT data with regard to ocean fisheries is discussed in this case study. Tracking fish populations, indirect assistance in forecasting expected populations and assistance to fishing fleets in avoiding costs incurred due to adverse weather through improved ocean conditions forecasts were investigated.
IX	Ports and Harbors - Case Study and Generalization	The case study and generalization quantify benefits made possible through improved weather forecasting resulting from the integration of SEASAT data into local weather forecasts. The major source of avoidable economic losses from inadequate weather forecasting data was shown to be dependent on local precipitation forecasting.
X	A Program for the Evalu- ation of Operational SEASAT System Costs	A discussion of the SATIL 2 Program which was developed to assist in the evaluation of the costs of operational SEASAT system alternatives. SATIL 2 enables the assessment of the effects of operational requirements, reliability, and time- phased costs of alternative approaches.

data.* The preliminary economic assessment identified large potential benefits from the use of SEASAT-produced data in the areas of Arctic operations, marine transportation, and offshore oil and natural gas exploration and development.

During Fiscal Year 1976, the effort was directed toward the confirmation of the benefit estimates in the three previously identified major areas of use of SEASAT data, as well as the estimation of benefits in additional application areas. The confirmation of the benefit estimates in the three major areas of application was accomplished by increasing both the extent of user involvement and the depth of each of the studies. Upon completion of this process of estimation, we have concluded that substantial, firm benefits from the use of operational SEASAT data can be obtained in areas that are extensions of current operations such as marine transportation and offshore oil and natural gas exploration and development. Very large potential benefits from the use of SEASAT data are possible in an area of operations that is now in the planning or conceptual stage, namely the transportation of oil, natural gas, and other resources by surface ship in the Arctic regions. In this case, the benefits are dependent upon the rate of development of the resources that are believed to be in the Arctic regions, and also dependent upon the choice of surface transportation over pipelines as the means of moving these resources to the lower

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*SEASAT Economic Assessment, ECON, Inc., October 1974.

latitudes. Our studies have also identified that large potential benefits may be possible from the use of SEASAT data in support of ocean fishing operations. However, in this case, the size of the sustainable yield of the ocean remains an unanswered question; thus, a conservative viewpoint concerning the size of the benefit should be adopted until the process of biological replenishment is more completely understood.

With the completion of this second year of the SEASAT Economic Assessment, we conclude that the cumulative gross benefits that may be obtained through the use of data from an operational SEASAT system, to provide improved ocean condition and weather forecasts is in the range of \$859 million to \$2,709 million (\$1975 at a 10 percent discount rate) from civilian activities. These are gross benefits that are attributable exclusively to the use of SEASAT data products and do not include potential benefits from other possible sources of weather and ocean forecasting that may occur in the same period of time. The economic benefits to U.S. military activities from an operational SEASAT system are not included in these estimates. A separate study of U.S. Navy applications has been conducted under the sponsorship of the Navy Environmental Remote Sensing Coordinating and Advisory Committee. The purpose of this Navy study was to determine the stringency of satellite oceanographic measurements necessary to achieve improvements in

military mission effectiveness in areas where benefits are known to exist.* It is currently planned that the Navy will use SEASAT-A data to quantify benefits in military applications areas. A one-time military benefit of approximately $30 million will be obtained by SEASAT-A, by providing a measurement capability in support of the Department of Defense Mapping, Charting and Geodesy Program.

Preliminary estimates have been made of the costs of an operational SEASAT program that would be capable of producing the data needed to obtain these benefits. The hypothetical operational program used to model the costs of an operational SEASAT system includes SEASAT-A, followed by a number of developmental and operational demonstration flights, with full operational capability commencing in 1985. The cost of the operational SEASAT system through 2000 is estimated to be about $753 million ($1975, 0 percent discount rate) which is the equivalent of $272 million ($1975) at a 10 percent discount rate. It should be noted that this cost does not include the costs of the program's unique ground data handling equipment needed to process, disseminate or utilize the information produced from SEASAT data. Figures 1.1 and 1.2 illustrate the net cumulative SEASAT exclusive benefit stream (benefits less costs) as a

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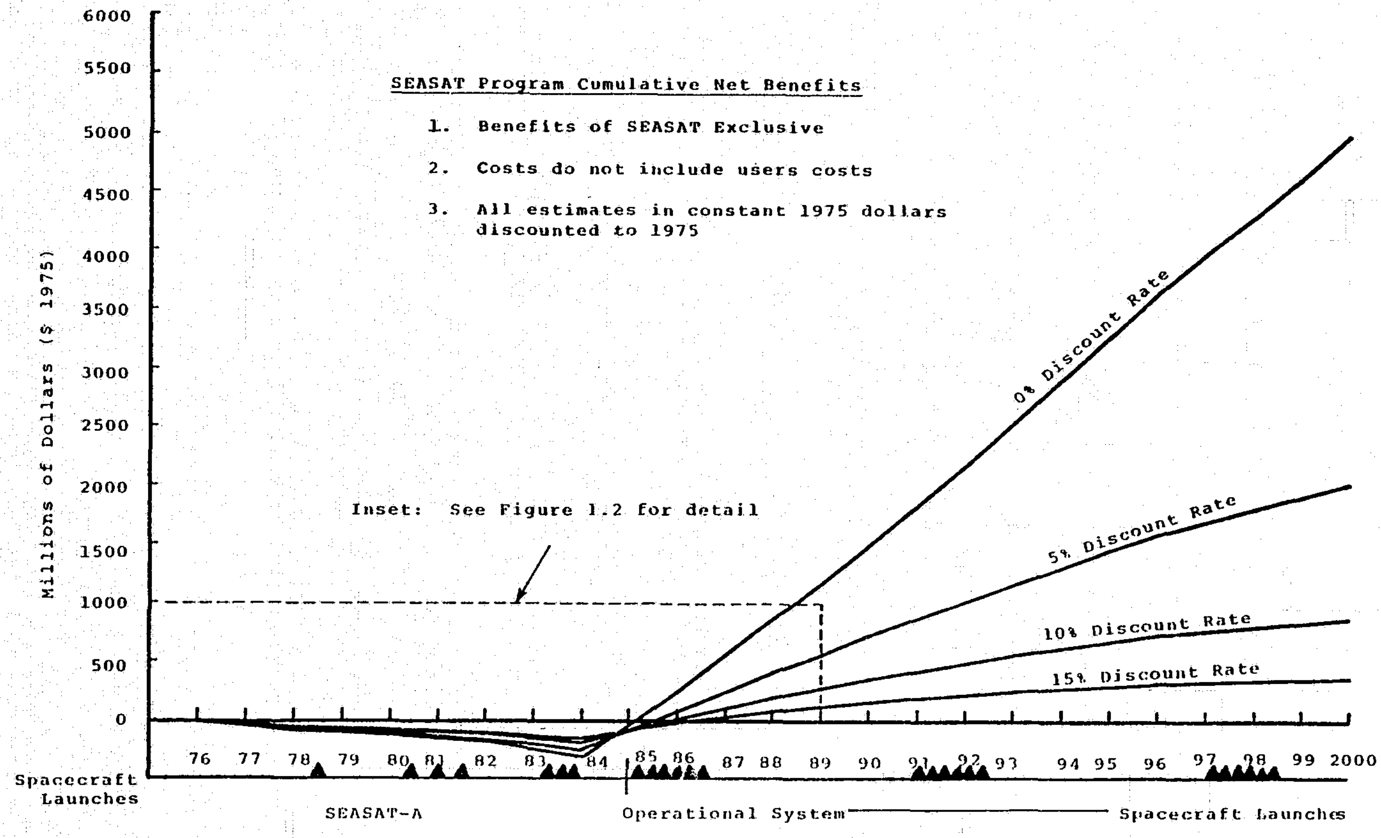
*"Specifications of Stringency of Satellite Oceanographic Measurements for Improvement of Navy Mission Effectiveness." (Draft Report.) Navy Remote Sensing Coordinating and Advisory Committee, May 1975.



Costs*	19	49	78	100	123	151	184	239	307	352	368	373	375	393	437	503	546	566	568	587	629	695	738	753
Benefits*										311	622	933	1244	1555	1937	2319	2701	3083	3465	3847	4229	4611	5375	5757

*Cumulative Costs and Benefits at 0% Discount Rate (millions, $ 1975)

Figure 1.1 SEASAT Program Net Benefits, 1975-2000

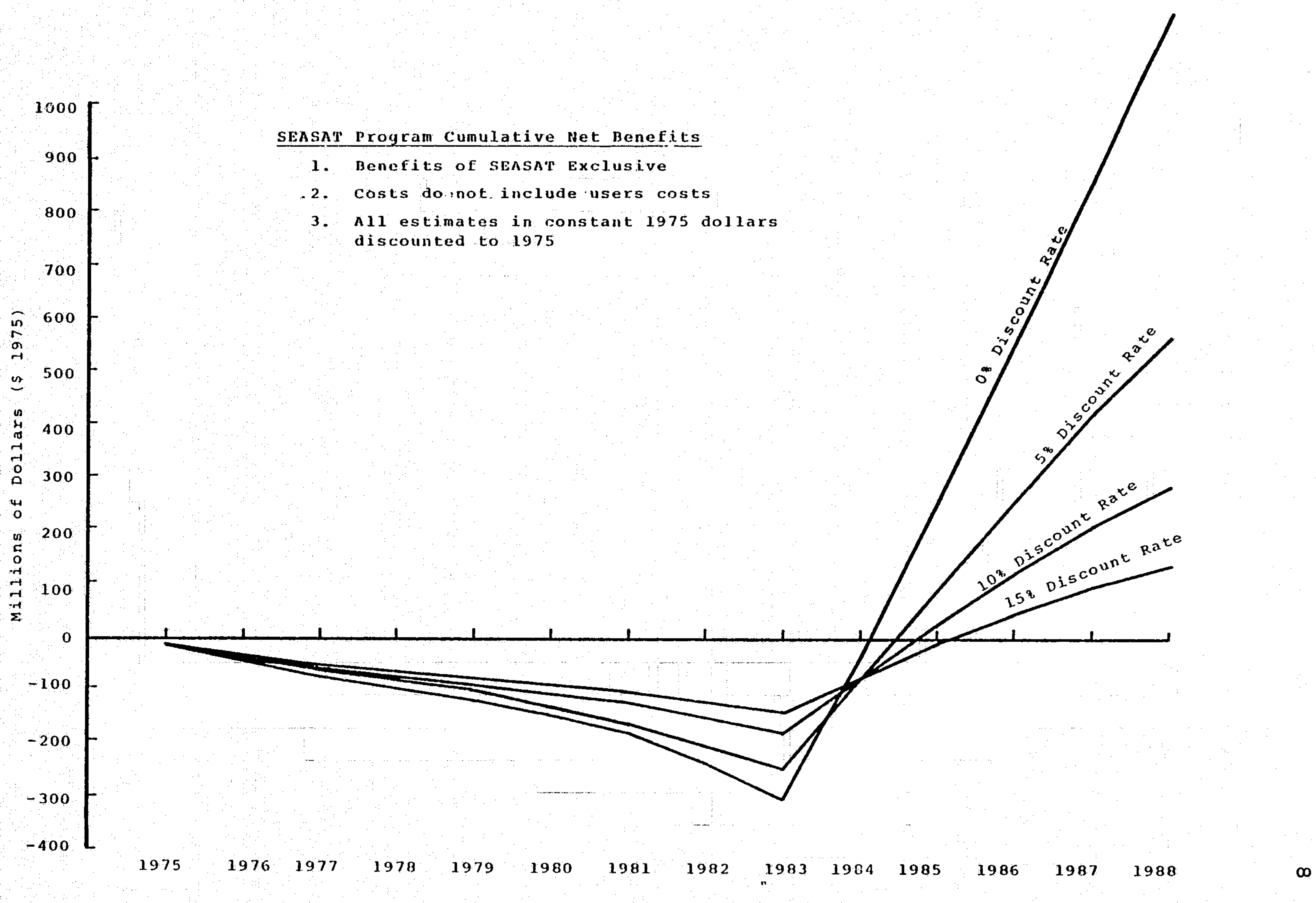


Figure 1.2 SEASAT Program Net Benefits
(Inset from Figure 1.1)

function of the discount rate.

This volume describes a mathematical program called SATIL 2 which has been developed to aid in the programmatic evaluation of alternative approaches to establishing and maintaining a specified mix of operational sensors on spacecraft in an operational SEASAT system.

2. INTRODUCTION

The evaluation and comparison of alternatives which are based upon technologies in various stages of research, development, design, and use should take into account not only expected cash flows and present values, but should also take into account the associated levels of risk. Risk may be characterized as the probability that pertinent evaluation measures exceed specified values. Major contributors to risk are system unreliability, performance uncertainties, and cost uncertainties. Because of the normally complex interactions between performance, reliability, and cost, it is desirable to consider these factors simultaneously when establishing the probability distributions of measures such as annual cash flows and present value of cash flow.

This report is concerned with the documentation of the SATIL 2 program which computes the probability distributions of events (i.e., number of launch attempts, number of spacecraft purchased, etc.), annual recurring cost, and present value of recurring cost. This is accomplished for the specific mission of placing a mix of sensors in orbit in an optimal fashion in order to satisfy a specified sensor demand function. The optimization is based upon selecting the mix of spacecraft buses (the platform consisting of the basic housekeeping and support functions upon which the

sensors are mounted), sensors and launch schedule which minimizes the present value of satisfying the specified sensor demand (as a function of time) requirements. The SATIL 2 program models the interactive effects of reliability, performance, and cost.

This report consists of a brief overview of the methodology for evaluating alternatives which explicitly takes into account reliability and cost uncertainties and develops quantitative risk measures. The methodology makes possible the comparison of alternatives with the explicit consideration of risk. The methodology also allows an economic value to be established for changes in requirements and/or capabilities. For example, the economic value of subsystem reliability improvements can be assessed and can be of considerable importance when making reliability allocations.

SATIL 2 is intended to work with a data set which describes the operational SEASAT system requirements and alternatives. Because of time constraints, it was not possible to develop a SEASAT data set during this phase of the work. The development of a SEASAT data set and the use of SATIL 2 to evaluate the costs of operational SEASAT alternatives is planned for a subsequent effort during FY-1976. However, to demonstrate the methodology and the capability of the SATIL 2 program, the economic consequences

of unreliability are considered for a hypothetical space mission requiring the emplacement and maintenance (for an extended period of time) of a system of earth observation sensors in geocentric orbits. The demand for sensors may be satisfied by utilizing different spacecraft types, each with a different mix of on-board sensors and each requiring a different transportation system capability. The objective is to select that mix of spacecraft and launch schedule which provides at least the desired sensor demand and which minimizes the present value of the costs. Reliability plays an important role in this analysis since the number of sensors which must be placed in orbit each year depends upon those which were placed in orbit in previous years and are no longer operational. The hypothetical example illustrates an assessment of the effects of operational requirements, performance capability, and reliability (spacecraft support subsystems, sensors, and all pertinent operational aspects of the transportation systems) on the time phased costs of alternative approaches. It also illustrates how the impact of technology improvements, reliability variation, and their combined effects can be evaluated by considering the present value probability distributions.

The value of reliability improvement and/or technology improvements can be established as the change in the present value of recurring costs with and without the

improvements. The value of risk reduction through both reliability improvements and operational capability is also discussed.

2.1 Uncertainty, Risk, and Decision Making

A typical problem confronting decision makers is to determine the cost, present value, etc., of alternative ways of satisfying a mission requirement and, thence, to select that alternative which minimizes a performance measure such as total cost, present value, etc. Since, in the aerospace industry, the decision is usually concerned with selecting an alternative from among a set of alternatives which utilize different technologies, are in various stages of planning, research, design and development, different levels of uncertainty, and hence, risk exists. The comparison and selection of the various alternatives should consider the different levels of risk. The addition of the risk dimension is illustrated in Figure 2.1 and implies the consideration of reliability and cost and performance uncertainties.

The economic analysis of space programs involves cash flow patterns that occur over several (n) years; thus, it is desirable to present the results of economic analyses (which combine the interactive effects of performance, cost, and mission requirements) in terms of the present value of costs. The present value, which explicitly takes into

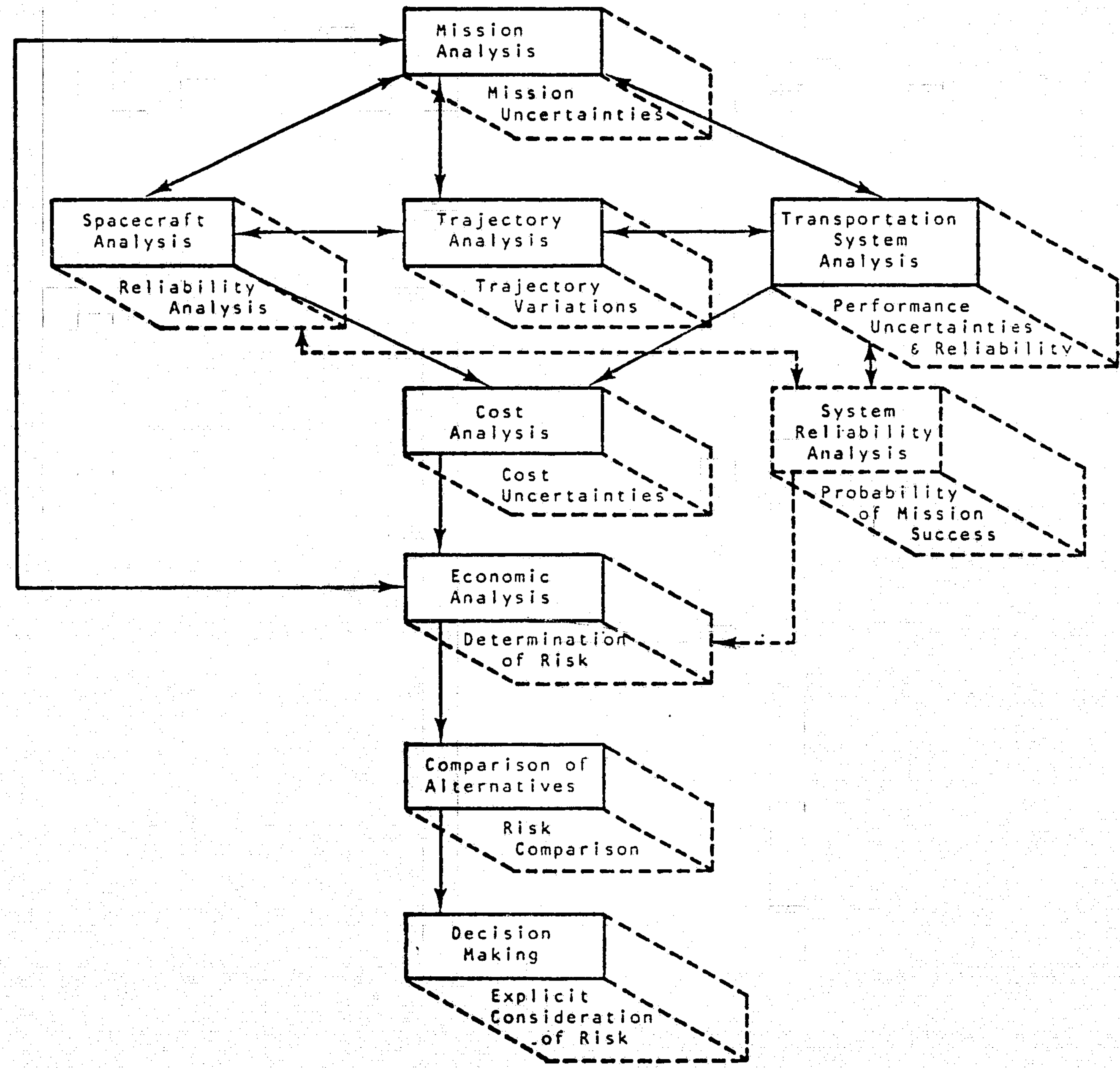


Figure 2.1 Space Systems Analyses and Decision Making

account the magnitude and the timing of the cash flow patterns, is defined as the summation of future annual costs discounted to the present and is given by

$$PV = \sum_{i=1}^{N} \frac{C_i}{[1+(r/100)]^i}$$

where PV=present value of cost, C_i=cost in the i^{th} year, and r=discount rate (%) or cost of capital.

The costs entering into the above equation, however, are not deterministic quantities. Variations in the yearly costs, C_i, occur because of the uncertainties in predicting future item (or per event) costs and due to the uncertainty both in the number of events necessary to perform the desired program and the time of occurrence of these events. Thus, the present value of costs must also be characterized by a probability distribution. The probability of present value exceeding a specified level is the area under the probability density curve for all values greater than the specified level and is henceforth referred to as a risk profile. Typical risk profiles of present value are shown in Figure 2.2 where the probability or chance, p, of exceeding the various levels of present value, PV, is indicated. In general, the steeper the curve, the lower the risk (or variability). When comparing alternatives, it is important to compare the

expected or most likely present values. It is equally important to also compare risk levels [1-4].*

Figure 2.2 illustrates the risk profiles of present value for two hypothetical alternatives, A and B. It should be noted that the expected, median (p=0.5), or most likely** present values of the two alternatives are equal. A decision maker performing a traditional analysis usually evaluates only the most likely present value. To this uninformed decision maker, alternatives A and B "look alike".

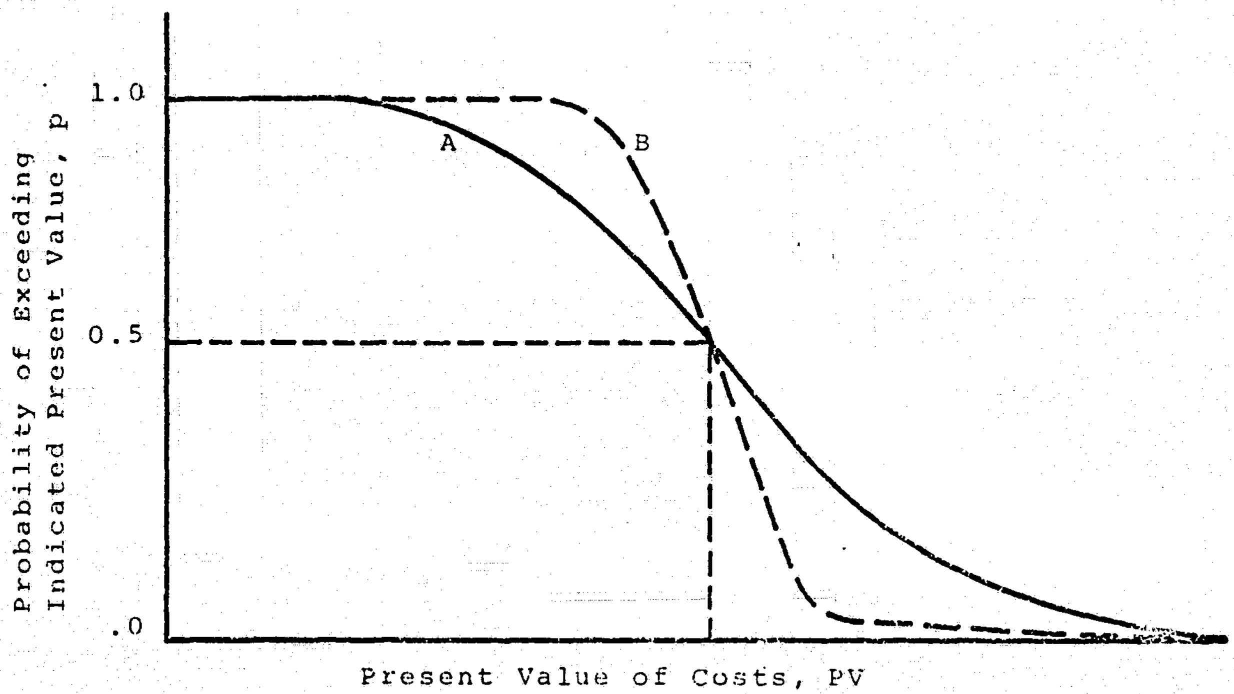


Figure 2.2 Risk Profile of Present Value

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*Numbers in brackets refer to references.

**Since present value probability distributions generally tend to be normal, the expected, median, and most likely values are approximately the same.

In the certainty situation, it is generally desirable to select the alternative which yields the minimum present value of costs when all alternatives are evaluated on an equal capability* basis. When present values are equal, the choice is immaterial. The selection process becomes more difficult when uncertainties are considered; tradeoffs must be made between alternatives possessing different expected present values and associated levels of risk. When the risk dimension is available, Alternatives A and B are found to be quite different. The risk associated with Alternative A is greater than that of Alternative B. Thus, a conservative decision maker** would normally select Alternative B, provided that other unquantified pressures to select Alternative A do not exist.

Generally, one can identify many alternatives that must be compared for selection of the best one. The problems of comparison are eased somewhat by the fact that the probability distributions of the present value of costs are usually very nearly normal. Thus, the distributions can be fully characterized by their mean, m, and standard deviation, σ, and

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*Equal capability is defined as providing the same level of service.

**Conservative in the sense that risk aversion preferences are evident.

each alternative can be represented by a point on the m-σ plane. An example is illustrated in Figure 2.3. Here, Alternatives 1 and 2 have the same level of risk (i.e., $\sigma_1=\sigma_2$), but the expected PV of the cost of Alternative 2 is greater than that of Alternative 1. Therefore, Alternative 1 is preferable to Alternative 2. In a similar manner, it can be argued that Alternative 3 is preferable to Alternative 4. Also in a similar manner, Alternative 3 is preferable to Alternative 1, since both have the same expected PV, but Alternative 1 is riskier.* This process can be continued

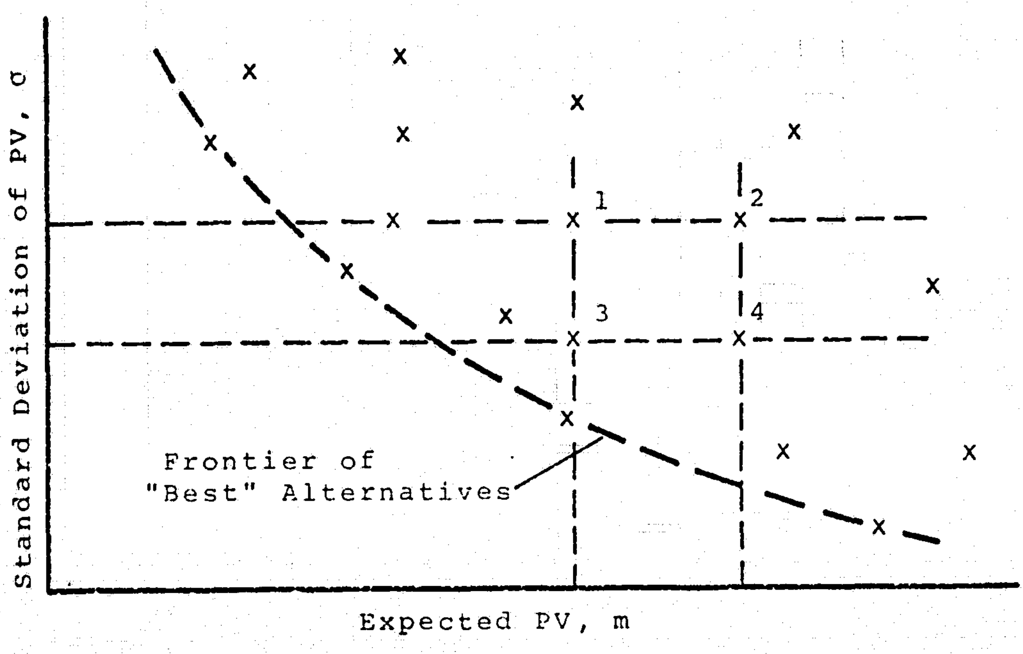

Figure 2.3 General Problem of Decision Making Under Uncertainty

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*This assumes a rational risk averse decision maker.

with all alternatives being considered. In the limit, it can be seen that a frontier of "best" alternatives can be established. Each of the points or alternatives represented by the frontier are different in the respect that the risk and expected PV are different. The class of best alternatives has thus been obtained and the "best" alternative can then be selected based on the decision maker's risk judgment. That is, the decision maker must decide what the tradeoff is between a reduction in expected PV of cost and an accompanying increase in risk.

The risk judgment may be purely intuitive or it may be based on a quantified utility function [5,6]. In each case, the tradeoff between expected rewards and risk is made explicitly clear to the decision maker.

It is clear from Figure 2.3 that the economic value of pursuing Alternative 1 relative to Alternative 2 is m_2-m_1 and Alternative 3 relative to Alternative 4 is m_4-m_3. Thus, one could afford to spend up to an additional amount m_2-m_1 on non-recurring costs in order to achieve Alternative 1 and still be better off than with Alternative 2. Considering Alternatives 1 and 3 with equal expected present value of costs, the value of Alternative 3 relative to Alternative 1 is clearly associated with risk reduction and can be assessed either intuitively or by developing utility functions. Again,

one can afford to spend an additional amount of up to this established value on non-recurring costs to achieve Alternative 3.

The following paragraphs are concerned with the methodology incorporated into the SATIL 2 program for establishing the annual cost probability distributions in terms of reliability and cost uncertainties and establishing the PV probability distribution.

2.2 The SATIL 2 Methodology (Overview)

Because of the complex interactions of performance, reliability and cost, the methodology [7,8,9] for evaluating the annual cost and present value probability distributions is based upon Monte Carlo simulation modeling techniques [10]. Specifically, a simulation model has been developed to assist with the programmatic evaluation of alternative approaches to establishing and maintaining a specified desired mix of operational sensors on spacecraft in geocentric orbits. The program enables the assessment of the effects of operational requirements and reliability (spacecraft support subsystems, sensors, and transportation systems) on the time phased costs of alternative approaches to satisfying mission requirements. The program is specifically designed to allow for the explicit consideration of reliability and cost uncertainties. In order to perform this evaluation, the launch systems and spacecraft

(support systems* and sensors) are considered in detail from the points of view of reliability and cost. All costs are treated as uncertainty variables where ranges of possible values are considered as well as subjective estimates pertaining to the form of the uncertainty (the probability distribution) within the range. The input to the program consists primarily of a set of numbers which describes the demand for various operational sensors in orbit as a function of time, the mix of sensors available per spacecraft type, the transportation system to be used for each spacecraft type as a function of time, spacecraft subsystem, sensor and transportation system reliability, spacecraft and transportation system costs including explicit quantitative uncertainty assessments and cost learning rates. The output from the simulation program consists of a set of probability distributions associated with costs and events (i.e., number of launch attempts, etc.) as functions of time and the probability distribution of the present value of total recurring cost.

The reliability, uncertainty and risk assessment capability embodied in the simulation model allows for:

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*The group of support systems is frequently referred to as the spacecraft bus.

- the specification of the mix of operational sensors required in geocentric orbits as a function of time;
- the consideration of multiple spacecraft which are defined in terms of the reliability of the major support subsystems, the mix of on-board sensors and their reliability and spacecraft cost;
- the consideration of spacecraft subsystem and sensor failure models which allow for both random and wearout failures;
- the specification and consideration of multiple transportation systems which may consist of current or new expendables or the space shuttle. The transportation systems may also include (as necessary) orbit-to-orbit shuttles or propulsion modules (for example, Agena, Centuar, Space Tug, etc.). The propulsion modules may be expendable or reusable and may be used for placing space-craft in orbit and retrieving spacecraft which fail and require replacement. The specification of the transportation systems include cost and reliability assessments. Reliability is considered at the major subsystem level;

- the specification of transportation systems to be utilized for placing different spacecraft into orbit as a function of time. Changing the specification of transportation system-spacecraft assignment as a function of time allows performance capability (such as allowable mission modes and reliability) and cost variations to be considered;
- the explicit consideration of multiple time periods, thus allowing for annual costs to be established;
- the consideration of cost learning curves and
- all costs to be treated as uncertainty variables.

The simulation model, taking into account the required number of sensors as a function of time, number of operational sensors in orbit (as determined from spacecraft subsystem and sensor reliability characteristics) and spacecraft and launch costs, determines a near-optimal mix of spacecraft launches as a function of time. Since the simulation is based upon Monte Carlo techniques, it is possible to establish the probability distributions of pertinent performance measures which allows alternatives to be compared by considering both expected values of

performance measures and the chance of variation (i.e., the risk) of the values of the measures. Specifically, the simulation model establishes the probability distributions of:

- pertinent quantities by year (for example, number of launch attempts, number of spacecraft required, number of propulsion modules required, number of propulsion module refurbishments, etc.);
- launch, spacecraft, and total costs by spacecraft type and by year and
- present value of recurring costs.

The basic structure of the simulation model is illustrated in Figure 2.4 and is typical of that required to evaluate service-type* of missions. The overall simulation model consists of a number of submodels, namely a Unit Cost Model, Sensor/Spacecraft Reliability Model, Demand/Scheduling Model, Operational Analysis Model, and an Annual Cost Model. Each of these are described briefly below.

Unit Cost Model: The Unit Cost Model establishes the cost associated with each of the cost incurring events.

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*Those missions requiring an establishment and maintenence of service (for example, remote sensing of earth resources, ocean surveilance, etc.).

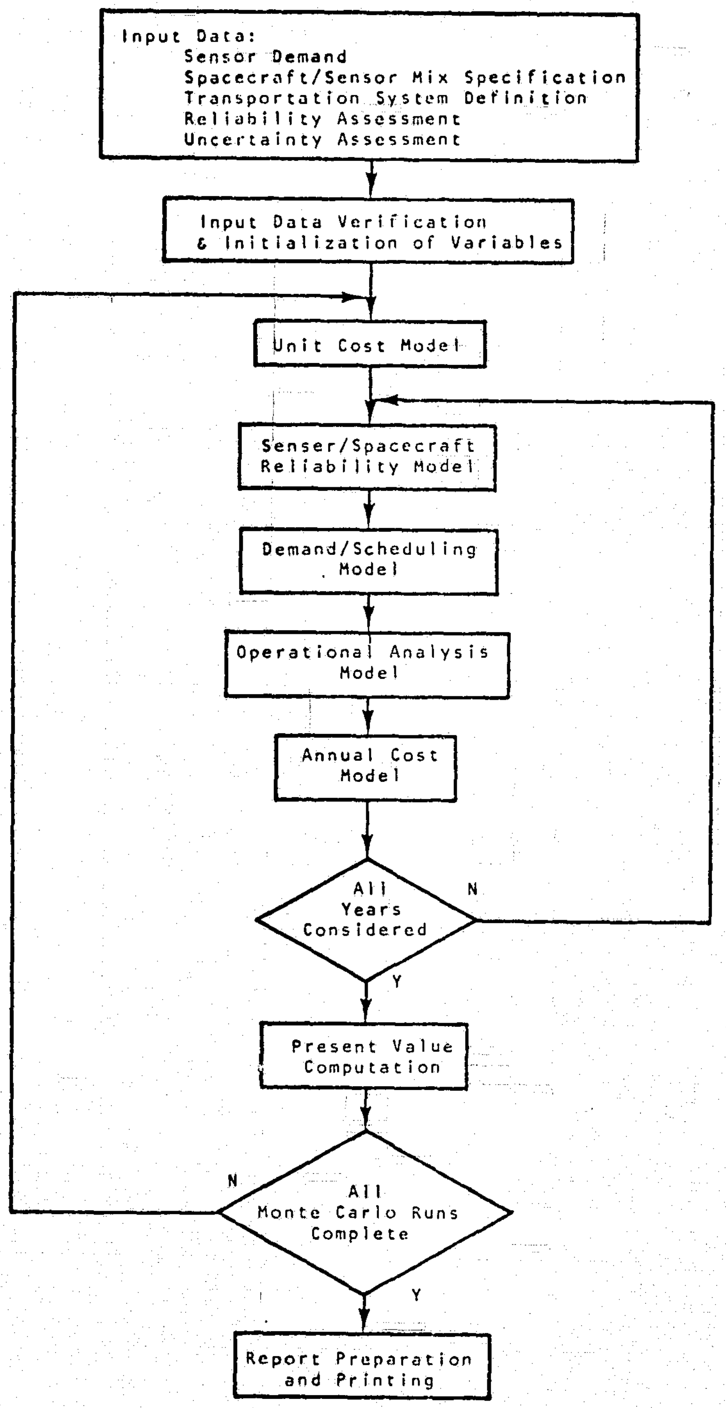


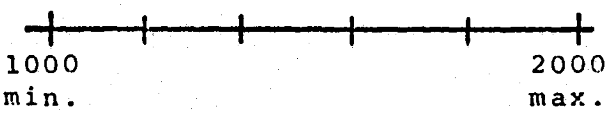
Figure 2.4 Basic Structure of The SATIL 2 Simulation Model

That is, it establishes the initial cost per launch, propulsion module refurbishment, spacecraft bus purchase, etc. The costs are established once for each Monte Carlo simulation run and are basically first unit costs. Future costs take into account learning effects and are discussed in the Annual Cost Model.

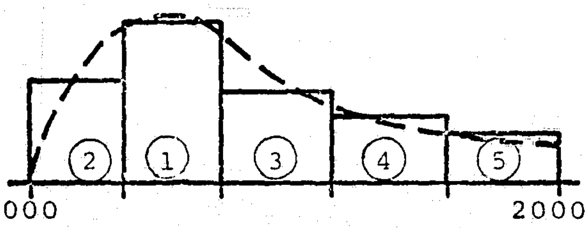
Recurring cost uncertainties arise from the difficulties of predicting the cost of producing an item before it has been designed. An overall economic analysis must be concerned with these uncertainties. The problem is how to quantify uncertainty. This requires that informed estimates be made of the ranges of uncertainty of key cost variables and their probability distributions within the range. The estimates of uncertainty might be made, for example, at the CER (cost estimating relationship) level or they might be made at the unit cost level. The uncertainty assessments [4,11] can be made by individuals with the assistance of an experienced analyst or they can be made by an experienced group of analysts using Delphi-type techniques. The estimates are very subjective in nature and quantitatively express the attitudes regarding the uncertainties. The estimates reflect past experience with similar efforts, problems which have been encountered in the past, insights into problem areas which might develop, etc.

A methodology for establishing the shape of the cost certainty profiles is illustrated in Figure 2.5 and has been employed in many previous risk analyses. The first step is to establish the range of unit cost uncertainty based on knowledgeable persons assessing what can go right and what can go wrong. The range is then divided into five equal intervals and a relative ranking of the likelihood of the cost variable falling into each of the intervals is performed. The general shape (skewed left, skewed right, central, etc.) of the uncertainty profile is thus established. The next step is to establish relative values of the chance of falling into each of the intervals. For example, in the illustration, the chance of falling into the first interval is estimated to be half as likely as falling into the second interval. This is repeated for each interval relative to the previously considered interval. The last step is to solve the illustrated equation for the quantitative values by substituting the data from the previous step.

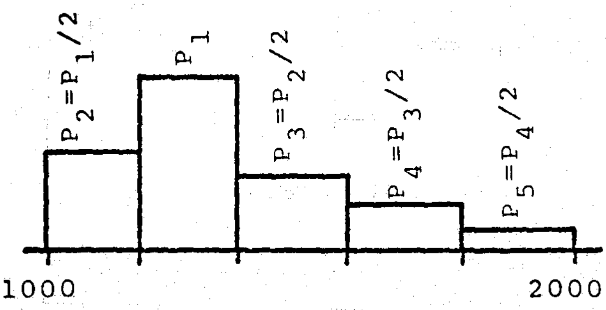
In order to simplify this procedure, a large number of typical uncertainty profiles are stored in the computer. The evaluator may thus simply specify the range of uncertainty (minimum and maximum values) and the name of the uncertainty profile which reasonably represents his feelings. If none of the stored profiles is suitable, then the previously described procedure may be followed.



a) Specify Range of Uncertainty



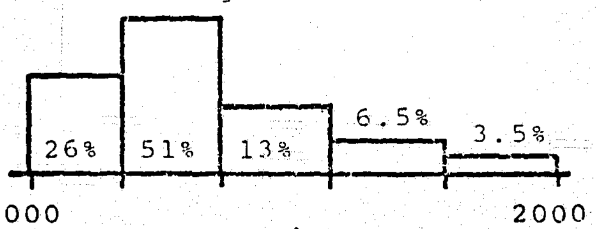
b) Perform Ranking (Qualitative)



c) Establish Relative Values

$$P_1 + P_2 + P_3 + P_4 + P_5 = 1$$

By Substituting from (c) Solve for P Values



d) Establish Quantitative Values

Figure 2.5 Methodology for Establishing Shape of Cost Uncertainty Profile

The Unit Cost Model is based upon the above methodology. The Unit Cost Model employs minimum and maximum cost estimates and the associated uncertainty profiles (probability distributions) and random sampling techniques to determine the unit costs which are to be used for each of the Monte Carlo simulation runs.

Sensor/Spacecraft Reliability Model: The purpose of the Sensor/Spacecraft Reliability Model is to determine, based upon estimated failure characteristics, which of the previously-launched sensors are still operational in the time frame being considered.

A service mission typically consists of two phases, namely the establishment of a desired level of service and the maintenance of that level of service. The establishment of the service is concerned with successfully placing a number of sensors in orbit over a period of time as determined by service needs. If it is assumed that both the need and the capability of the spacecraft are known, it follows that the number of spacecraft required to establish the service is deterministic. The maintenance of the service is concerned with maintaining the desired number of operational sensors in service. As a result of less-than-perfect reliability and variability associated with wearout phenomena, such as attitude control gas depletion, failures will occur in a random manner with the result that the traffic associated

with the maintenance of the service will be known only in a probabilistic sense. The probabilistic nature of the traffic due to spacecraft failures and replacements adds an important degree of uncertainty and risk to the service mission. It is, therefore, necessary to consider the impact of reliability on the overall mission.

Spacecraft failures occur as the result of four causes: improper design or manufacture generally due to an incomplete understanding of all related physical principles, imperfect quality control during manufacture, uncertainties in the environment during storage, transportation and operation, and because of design and technology limitations generally associated with lifetime. These failure causes generally manifest themselves in three different types of failures: early, chance, and wearout. In this paper, early spacecraft failures are considered in the Operational Analysis Model. Their consequences are dependent upon the Space Transportation System and the operational modes.

The general failure model [8] utilized in this analysis considers both random and wearout failures and is given by

$$R(n) = \frac{\exp(-\lambda n)}{\sigma_f (2\pi)^{1/2}} \int_n^{\infty} \exp\left[- \frac{(a-M_f)^2}{2\sigma_f^2} \right] da$$

This expresses the combined effects of the random and wearout phenomena as the probability of surviving through the n^{th} time period (years) and λ is the failure rate (failures/year) or reciprocal of the mean-time between failures (MTBF), M_f is the mean or expected wearout life (years) and σ_f is the standard deviation of wearout life (years). The probability of a failure in time period n, F(n), given success to the beginning of time period n is thus

$$F(n) = \left[R(n-1) - R(n)\right] \Big/ R(n-1).$$

The failure characteristics can be modeled by estimating, based on current design and/or past experience, the anticipated MTBF ($1/\lambda$) for the random failures and the expected wearout life and the standard deviation of wearout life. Although this failure model is a very simple one, it serves to illustrate the way in which reliabilities enter into the economic analysis. More detailed reliability models could be developed as necessary.

The Sensor/Spacecraft Reliability Model considers the reliability of each of the sensors and each of the spacecraft support subsystems individually keeping track of when each is placed into orbit and determines by sampling techniques when each fails. Sensors are considered to be independent of each other, whereas sensor operation is dependent upon successful operation of all the support subsystems.

Demand/Scheduling Model: The purpose of this Model is to determine which spacecraft and sensor mix should be launched each year taking into consideration the number and type of operational sensors at the start of each year and future sensor demand and unit costs. The objective is to minimize the present value of recurring cost by selecting the optimum mix of spacecraft buses, sensors, and launch systems and schedule such that the demand for sensors is always satisfied even though sensors placed in orbit in previous years may no longer be operational. The problem is complicated by the fact that it is assumed that several different spacecraft buses (group of support subsystems) are available which are capable of supporting different mixes of sensors.

The optimum solution can be obtained using an integer programming algorithm. However, because the Demand/Scheduling Model is contained within a Monte Carlo loop, a linear programming algorithm, with its increased computational speed, has been utilized to find a very near optimum solution. The objective function and constraints for the linear programming algorithm are as follows:

$$\text{Minimize} \left\{ \sum_{i=n}^{N} \left\{ PVF_i \times \sum_{j=1}^{J} (SC_{i,j}+LC_{i,j}) \times NA_{i,j} \right\} \right\}$$

subject to

$$NO_{k,n} + \sum_{j=1}^{J} \left\{ SX_{j,k} \times \sum_{i=n}^{N} NA_{i,j} \right\} \geq ND_{i,k}$$

for each i such that $n \leq i \leq N$ and $1 \leq k \leq K$, where

n = start of the time horizon (years),

N = number of time periods (years) to be considered,

PVF_i = present value factor applicable to the i^{th} time period,

J = maximum number of spacecraft bus types,

$SC_{i,j}$ = cost ($) of the j^{th} spacecraft (bus plus sensors) in the i^{th} year,

$LC_{i,j}$ = cost ($) of launching the j^{th} spacecraft in the i^{th} year,

K = maximum number of sensor types,

$NO_{k,n}$ = number of sensors of type k operational at the end of the n^{th} year,

$SX_{j,k}$ = sensor types available on the j^{th} spacecraft (ϕ or 1),

$ND_{i,k}$ = number of sensors of type k required to be operational in the i^{th} year.

The above quantities are provided to the Demand/ Scheduling Model which thence determines $NA_{i,j}$, the number of spacecraft of type j to be placed successfully in orbit in the i^{th} year. $NA_{i,j}$ thence serves as a primary input to the Operational Analysis Model.

Operational Analysis Model: The function of the Operational Analysis Model [9] is the quantification of the probability distributions of the numbers of recurring cost-associated events required to establish and maintain the desired level of service (as determined by the Demand/Scheduling Model, i.e., the value of $NA_{i,j}$). These events may include the number of spacecraft purchased, the number of launches, the number of spacecraft retrievals or refurbishments, and so on. Each of these events has associated with it a cost that, at least in the planning phase, includes some uncertainty.

Operational analysis explicitly considers the possibility of failures in the space transportation systems, the chance of these failures occurring, and the consequences if the failures do indeed occur. More specifically, the analysis considers (1) the number, sequence, and complexity of operations to be performed, (2) the recovery modes, that is, given that a failure has occurred, the possible resulting sequences of events, and (3) the probability of successfully performing each of the required operations, both in the success and failure recovery sequences.

The Operational Analysis Model is based upon a generalized mission scenario. The mission scenario is defined as the timeline sequence of all possible events (within the

desired level of detail) that can occur from start to completion of a mission. The success-oriented path through the mission scenario is the mission profile. A typical mission profile based upon the Space Shuttle-Tug Transportation System is illustrated in Figure 2.6. Note that, in the general sense, this represents a multi-stage launch system. As will be discussed in following paragraphs, the multi-stage launch system may consist of various combinations of recoverable and reusable and/or expendable stages. This is possible by providing appropriate values for the various recovery probabilities. The mission scenario includes both the success-oriented paths and all of the pertinent failure recovery paths as well. The mission scenario can be depicted as a series of nodes connected by branches. Each node is a decision point representing a group of events. Emanating from each node are branches for the success and failure recovery paths. The probability of departing the node on one branch or another depends upon the probability of success (or failure) of the events represented by the node. The failure recovery paths must ultimately provide a route to mission completion (i.e., placing $NA_{i,j}$ spacecraft successfully into orbit). This mission scenario is illustrated in Figure 2.7 as a logic flow diagram where the nodes are represented by the diamond-shaped boxes and the branches as lines with major cost-associated events given in the rectangular boxes.

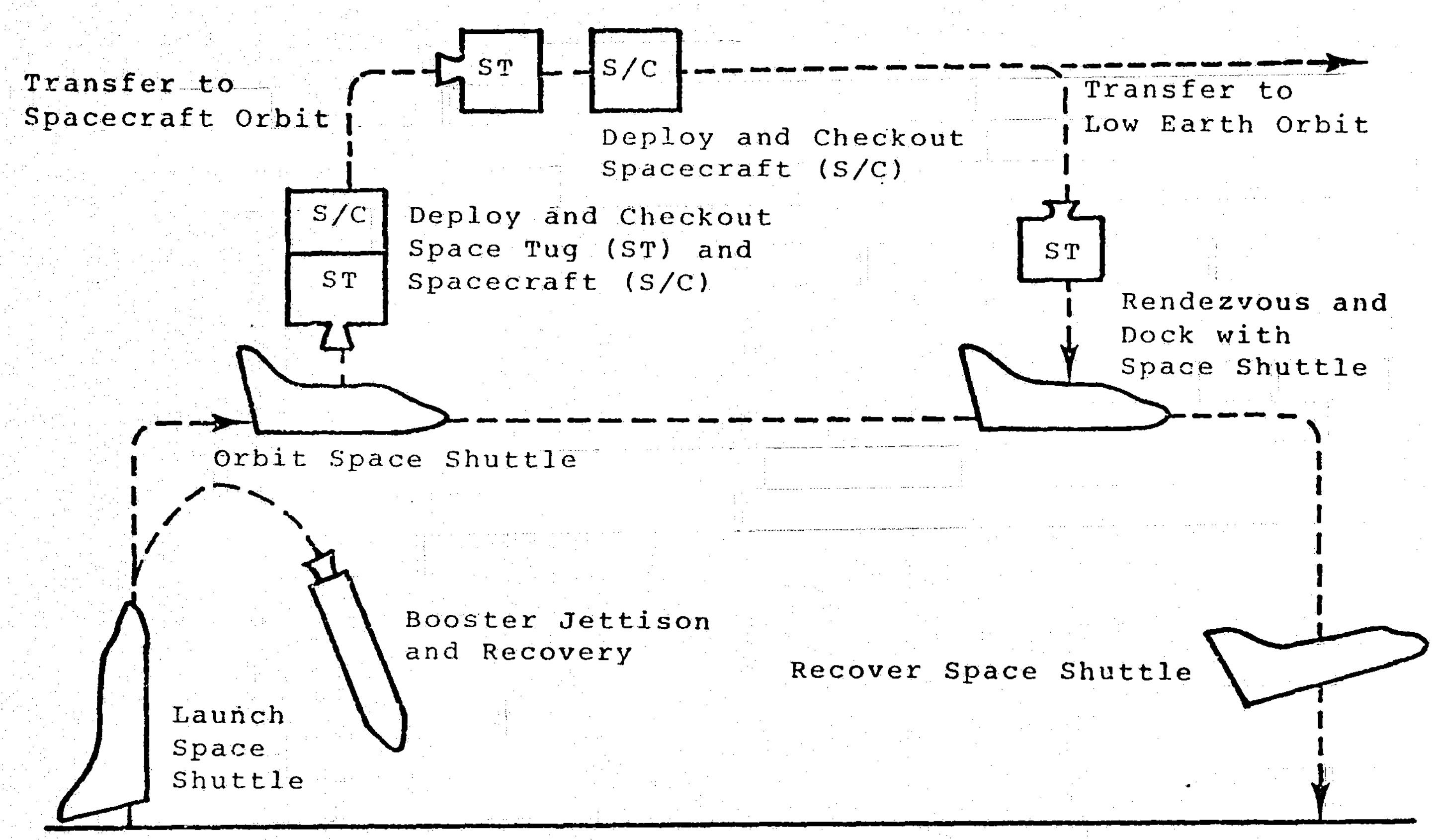


Figure 2.6 Space Shuttle-Space Tug Spacecraft Placement Mission Profile

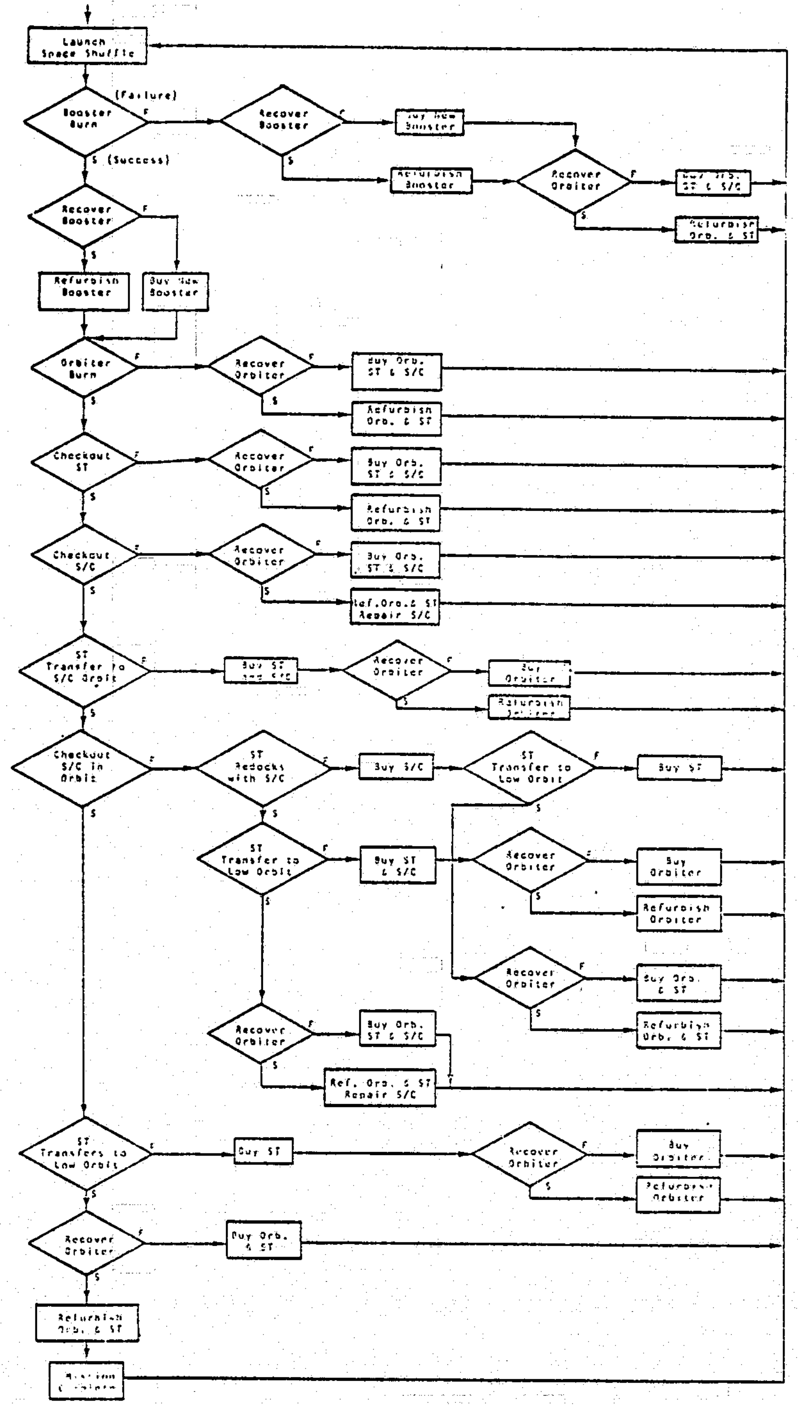


Figure 2.7 Space Shuttle - Space Tug Spacecraft Placement Mission Scenario

It should be noted that the logic diagram of the mission scenario is based upon the Space Shuttle - Space Tug spacecraft placement mission. The reason for this is that a large class of space transportation systems and associated scenarios form a subset of that shown in Figure 2.7. For example, the scenario for an expendable launch system is achieved simply by setting all of the appropriate probabilities (for example, probability of orbiter (upper stage) recovery) to zero.

The Operational Analysis Model establishes the probability distributions of the number of events which occur as a result of the requirement to place $NA_{i,j}$ spacecraft successfully in orbit. This is accomplished through the use of Monte Carlo techniques and the associated random sampling to determine which of the branches are to be followed at each of the nodes.

<u>Annual Cost Model</u>: The purpose of the Annual Cost Model is to establish the probability distribution of the annual recurring cost associated with the service-type of mission. The annual cost is established as the sum of the various unit costs multiplied by the associated number of events. The unit costs are adjusted individually on an annual basis to allow for learning effects as follows:

$$C_i = UC \times i^{\alpha}$$

$$\alpha = -1 + [\log_{1\phi} CAL - 1.699] / .3\phi 1$$

where C_i is the cost in the i^{th} year based upon a first unit cost of UC. α is the learning exponent and CAL is the cumulative average learning rate (%). When CAL=1ϕϕ, there is no learning. When CAL=8ϕ, the cost is reduced to 8ϕ% of its value every time the number of years doubles.

The unit costs are the result of sampling of the unit cost uncertainty profiles and ranges of uncertainty and the number of events is the result of the operational analysis simulation. By repeating the process a large number of times, the annual cost probability distributions are established.

The final step, after all time periods have been considered, is the establishment of the present value probability distribution and the expected value and standard deviation of PV.

2.3 An Application Example

To illustrate the use of the SATIL 2 program and to demonstrate typical results obtained from the explicit consideration of reliability and cost uncertainties,* a typical, though hypothetical, service mission is considered over a ten-year time period. It should be noted that this mission is

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*Cost uncertainties have not been considered in the results shown so that the impact of reliability considerations can be clearly seen.

strictly hypothetical and is not intended to represent an operational SEASAT program. It is planned that the data set needed for the analysis of operational SEASAT alternatives will be compiled jointly by NASA, JPL, and ECON during FY-1976. Estimates of costs using the SEASAT data set and the SATIL 2 program will be prepared during FY-1976.

The basic mission is described by the sensor demand function given in Table 2.1, where the assumed demand for five different sensors in geocentric orbits is illustrated for a 10-year period. Table 2.2 illustrates the assumed sensor/spacecraft mix based upon four spacecraft types. Spacecraft 1 can accomodate Sensors 1 and 2, Spacecraft 2 can accommodate Sensors 2 and 3, and so forth. The assumed reliability parameters are mean-time to failure, expected wearout life, and standard deviation of wearout life.

A typical specification of launch systems technology is illustrated in Table 2.4, where the probability of success of performing major operations is shown for five launch technologies. These technology specifications are representative of the Thor-Delta, Atlas-Centaur, Space Shuttle and Interim Upper Stage, Space Shuttle and Improved Interim Upper Stage, and Space Shuttle and Reusable Space Tug Transportation Systems, respectively. Table 2.5 describes the applicability of these launch technologies to placing each of the four spacecraft into orbit as a function of time. For example,

Table 2.1 Assumed Sensor Demand

Sensor	Year									
	1	2	3	4	5	6	7	8	9	1Ø
1	1	1	2	2	3	3	3	3	3	3
2	1	1	2	2	3	3	3	3	3	3
3	Ø	Ø	1	1	2	2	2	2	2	2
4	Ø	Ø	Ø	1	2	2	2	2	2	2
5	Ø	Ø	Ø	1	1	2	2	2	2	2

Table 2.2 Sensor/Spacecraft Mix

Sensor	Spacecraft			
	1	2	3	4
1	✓			
2	✓	✓		
3		✓		
4			✓	
5			✓	✓

Table 2.3 Sensor Reliability Assumptions

Reliability Item	Sensor				
	1	2	3	4	5
Mean Time to Failure (yrs)	5	7	7	5	5
Expected Wearout Life (yrs)	5	5	5	5	5
Std. Dev. of Wearout (yrs)	1	1	1	1	1

Table 2.4 Reliability Specifications of Launch Technology

Probability of Success for	Launch Technology* 1	2	3	4	5
Booster burn	.95	.95	1.Ø	1.Ø	1.Ø
Booster recovery given success	.Ø	.Ø	.Ø	.Ø	.5
Booster recovery given failure	.Ø	.Ø	.Ø	.Ø	.Ø
Orbiter achieves low earth orbit	.95	.95	1.Ø	1.Ø	1.Ø
Orbiter recovery given abort to orbit	.Ø	.Ø	1.Ø	1.Ø	1.Ø
Orbiter recovery given booster failure	.Ø	.Ø	1.Ø	1.Ø	1.Ø
Orbiter recovery from low earth orbit	.Ø	.Ø	1.Ø	1.Ø	1.Ø
Upper stage (i.e., space tug) checks out successfully in low earth orbit	1.Ø	1.Ø	.95	.95	.95
Upper stage transfers to s/c placement orbit	.95	.92	.95	.95	.95
Upper stage transfers from terminal orbit to low earth orbit and rendezvous with orbiter	.Ø	.Ø	.Ø	.9	.95
Upper stage reacquiring s/c which does does check-out in terminal orbit	.Ø	.Ø	.Ø	.Ø	.9

	s/c type 1	2	4	4
s/c checks-out in terminal orbit	.95	.9	1.Ø	1.Ø

*Probabilities of 1.Ø imply greater than Ø.99 chance of success.

it is assumed that Spacecraft 1 will be placed in orbit by the Thor-Delta during the first three years, by the Space Shuttle and Interim Upper Stage during the next three years, etc.

Table 2.6 illustrates the assumed costs for sensors, launch technologies, and spacecraft buses. The model allows

Table 2.5 Launch Technology Applicable per Spacecraft

Spacecraft	Time (years)									
	1	2	3	4	5	6	7	8	9	1Ø
1	1	1	1	3	3	3	4	4	5	5
2	2	2	2	3	3	3	4	4	5	5
3	2	2	2	3	3	3	4	4	5	5
4	2	2	2	3	3	3	4	4	5	5

Table 2.6 Cost Estimates* ($millions)

Sensor	Cost ($M)	Launch Technology	Cost ($M)	Bus	Cost ($M)
1	15	1	10	1	15
2	7	2	15	2	30
3	7	3	17		
4	5	4	15		
5	40	5	15		

*Costs assumed known with certainty

all of these costs to be treated as uncertainty variables (ranges plus probability distributions). However, since emphasis is being placed upon the effects of unreliability, all costs have been assumed to be known with certainty (i.e., single values).

The Mathematical Model develops, based upon the Monte Carlo methodology, probability distributions for all pertinent events and costs and present value of cost. Typical event statistics (based upon the data presented in the previous tables) are shown in Table 2.7, where the probability density function of launch attempts as a function of time is presented. This data encompasses the effects of both transportation sys- system and spacecraft (bus and sensors) unreliability. Table 2.8 illustrates the summary statistics, in terms of expected value and standard deviation of annual launch attempts, when all random failure rates (bus and sensors) are zero and all launch reliabilities are unity. Only bus wearout failures are considered (sensor wearout life is assumed in excess of bus wearout life). In effect, Table 2.8 illustrates the number of launch attempts that would be considered when allowing for "planned" replacement. The effect of random failures is immediately apparent by comparing the summary statistics in Tables 2.7 and 2.8.

Table 2.9 illustrates the probability density function of total annual recurring costs. The variability of the

Table 2.7 Probability of Indicated Number of Launch Attempts

Quantity	1	2	3	4	5	6	7	8	9	10
10	.0	.0	.0	.0	.0	.0	.01	.0	.0	.01
9	.0	.0	.02	.0	.0	.0	.01	.0	.01	.0
8	.0	.0	.03	.0	.03	.0	.02	.01	.02	.02
7	.0	.0	.06	.0	.05	.07	.03	.03	.02	.05
6	.0	.0	.07	.0	.10	.07	.07	.10	.04	.07
5	.0	.01	.25	.02	.16	.11	.15	.11	.08	.11
4	.0	.02	.34	.03	.33	.16	.18	.13	.27	.17
3	.01	.10	.23	.13	.30	.19	.26	.17	.19	.25
2	.15	.30	.0	.26	.03	.19	.22	.30	.23	.22
1	.84	.57	.0	.50	.0	.16	.04	.13	.12	.06
0	.0	.0	.0	.06	.0	.05	.01	.02	.02	.04
Year	1	2	3	4	5	6	7	8	9	10
Expected No.	1.17	1.60	4.56	1.63	4.27	3.21	3.71	3.20	3.26	3.51
Std. Dev.	.40	.82	1.40	1.02	1.36	1.89	1.79	1.78	1.72	1.89

Table 2.8 Launch Attempt Statistics Considering Only Spacecraft Bus Wearout Failures

	Year									
	1	2	3	4	5	6	7	8	9	10
Expected No.	1.00	1.00	3.01	.02	2.51	1.03	1.88	1.60	1.40	2.51
Std. Dev.	0	0	.10	.14	.50	.74	.99	.89	.95	1.24

Table 2.9 Probability of Indicated Total Launch & Spacecraft Costs

Cost Range (Millions of Dollars)										
480.00---500.00	0.0	0.0	0.0	0.0	0.020	0.0	0.0	0.0	0.0	0.0
460.00---480.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.010
440.00---460.00	0.0	0.0	0.0	0.0	0.020	0.0	0.0	0.0	0.010	0.0
420.00---440.00	0.0	0.0	0.0	0.0	0.010	0.010	0.020	0.0	0.010	0.010
400.00---420.00	0.0	0.0	0.0	0.0	0.0	0.010	0.010	0.010	0.0	0.010
380.00---400.00	0.0	0.0	0.020	0.0	0.020	0.030	0.020	0.010	0.0	0.020
360.00---380.00	0.0	0.0	0.0	0.0	0.0	0.020	0.020	0.030	0.020	0.020
340.00---360.00	0.0	0.0	0.030	0.0	0.020	0.050	0.020	0.040	0.030	0.0
320.00---340.00	0.0	0.0	0.010	0.0	0.040	0.020	0.020	0.010	0.010	0.050
300.00---320.00	0.0	0.0	0.050	0.0	0.060	0.030	0.050	0.020	0.030	0.060
280.00---300.00	0.0	0.0	0.0	0.010	0.080	0.070	0.080	0.110	0.030	0.040
260.00---280.00	0.0	0.0	0.070	0.0	0.030	0.010	0.030	0.050	0.080	0.050
240.00---260.00	0.0	0.0	0.0	0.010	0.140	0.080	0.050	0.020	0.010	0.030
220.00---240.00	0.0	0.0	0.150	0.020	0.130	0.060	0.100	0.080	0.120	0.060
200.00---220.00	0.0	0.0	0.100	0.0	0.020	0.040	0.010	0.010	0.050	0.010
180.00---200.00	0.0	0.010	0.0	0.050	0.220	0.120	0.150	0.050	0.090	0.160
160.00---180.00	0.0	0.020	0.340	0.0	0.020	0.030	0.050	0.030	0.030	0.020
140.00---160.00	0.010	0.0	0.0	0.070	0.140	0.050	0.120	0.030	0.080	0.120
120.00---140.00	0.0	0.040	0.230	0.030	0.0	0.050	0.060	0.110	0.130	0.080
100.00---120.00	0.0	0.060	0.0	0.040	0.0	0.0	0.030	0.040	0.040	0.060
80.00---100.00	0.150	0.150	0.0	0.200	0.030	0.110	0.100	0.190	0.110	0.090
60.00--- 80.00	0.0	0.150	0.0	0.020	0.0	0.030	0.010	0.010	0.010	0.0
40.00--- 60.00	0.840	0.0	0.0	0.490	0.0	0.130	0.040	0.130	0.090	0.060
20.00--- 40.00	0.0	0.570	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 20.00	0.0	0.0	0.0	0.060	0.0	0.050	0.010	0.020	0.020	0.040
Year	1	2	3	4	5	6	7	8	9	10
Expected Costs	55.0	61.8	202.0	82.8	241.1	187.8	203.7	176.7	180.8	192.7
Std. Dev.	18.9	34.1	62.2	56.9	80.1	110.8	93.7	103.7	95.1	103.4

costs and quantities (with cost uncertainties set equal to zero) is due to system and subsystem unreliability.

The risk profile of present value of recurring cost (i.e., probability of PV exceeding specified values) is illustrated in Figure 2.8. Since this risk profile is approximately normal, the expected, most likely and median values, are the same, i.e., $1037 million with a standard deviation of $132 million. If unreliability of launch systems and random spacecraft and bus failures are not considered (as in Table 2.8), the expected present value is $545 million with a standard deviation of $35 million.

The importance and economic value of unreliability is addressed in Figure 2.9 which indicates the effect of MTBF and expected wearout time (σ_f held constant). The value of achieving different MTBFs and M_fs is apparent. Moving from an expected wearout time of $M_{f,1}$ to $M_{f,3}$, and on $MTBF_1$ to $MTBF_3$, results in an expected economic value of m_1-m_3 and a reduction in risk of σ_1-σ_3. Thus, a development program should be undertaken which would move the technology from Point A to Point B if the expected present value of the cost of the development program were less than m_1-m_3. More precisely, it is necessary to develop the probability distribution of the present value of the development program and compare it with the probability distribution of the present value difference between technologies indicated as points A

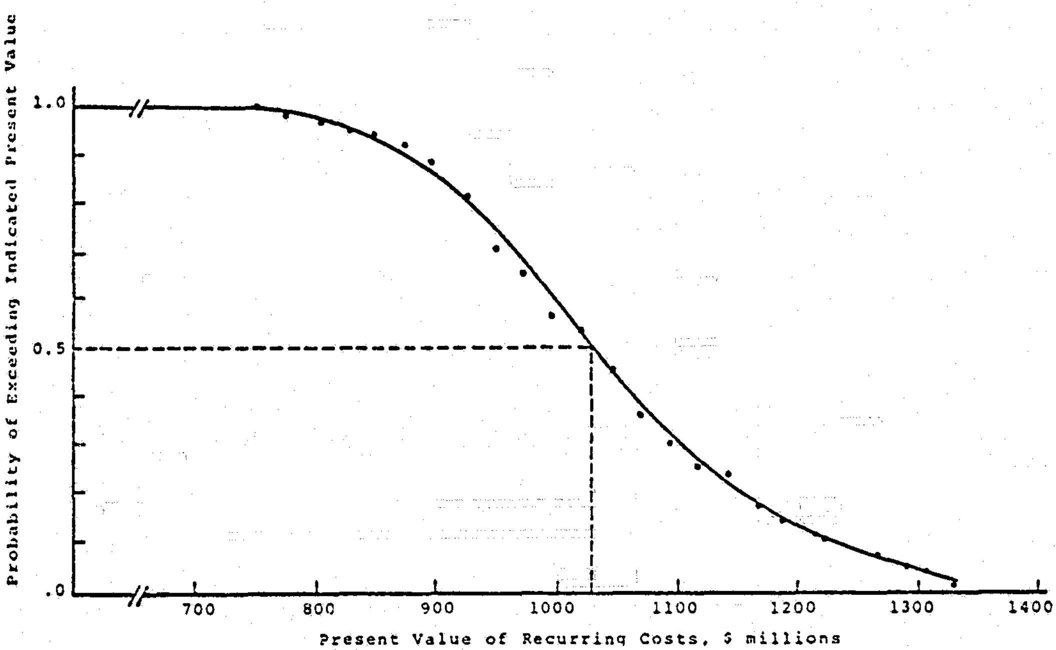


Figure 2.8 Present Value Risk Profile

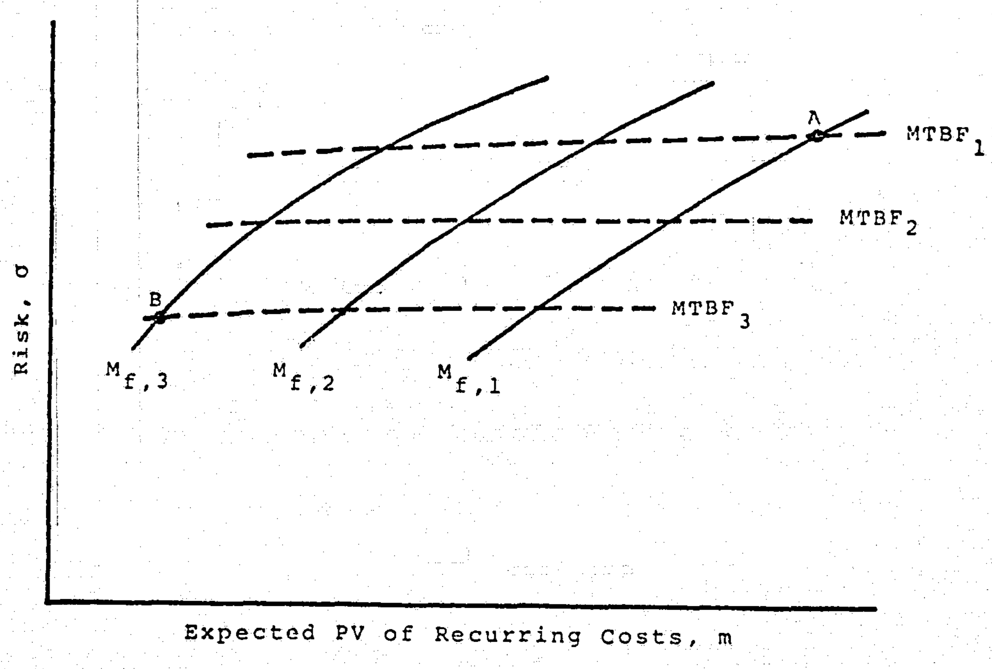


Figure 2.9 Effect of Spacecraft Reliability on Present Value of Recurring Cost

and B. Whether or not the development program to move from A to B should be undertaken depends upon the chance that the present value of development costs will exceed the reduction in the present value of the recurring costs and the decision makers risk aversion preferences. To illustrate the above quantitatively, m_1-m_3 is equal to \$24 million and σ_1-$\sigma 3$ is equal to \$12 million when bus expected wearout time is increased from four-to-eight years with a constant MTFB of 15 years, and the other parameters are as given in the previous tables.

The importance and economic value of unreliability is addressed in Figure 2.9 which indicates the effect of MTBF and expected wearout time (σ_f held constant). The value of achieving different MTBFs and M_fs is apparent. Moving from an expected wearout time of $M_{f,1}$ to $M_{f,3}$ and $MTBF_1$ to $MTBF_3$ results in an expected economic value of m_1-m_3 and a reduction in risk of σ_1-σ_3. Thus, a development program should be undertaken which would move the technology from point A to point B if the expected present value of the cost of the development program were less than m_1-m_3. More precisely, it is necessary to develop the probability distribution of the present value of the development program and compare it with the probability distribution of the present value difference between technologies indicated as points A and B. Whether or not the development program to move from A to B should be undertaken depends upon the chance that the present value of development costs

will exceed the reduction in the present value of the recurring costs and the decision makers risk aversion preferences. To illustrate the above quantitatively, $m_1 - m_3$ is equal to \$23 million and $\sigma_1 - \sigma_3$ is equal to \$12 million when bus expected wearout time is increased from four-to-eight years with a constant MTBF of 15 years and the other parameters are as given in the previous tables.

3. INPUT DATA REQUIREMENTS, DEFINITIONS AND DATA SHEETS

The SATIL 2 data requirements, definitions, and input data sheets are presented in the following pages. The Fortran name of the input data variable is presented along with the definition of the variable. Each variable has a reference number associated with it. This reference number appears on both the input data specification sheet and the input data sheet, thus allowing for easy cross-referencing.

A range of valid data is given for each of the input variables. If the input data does not lie within the valid range, an error message is printed and the program execution terminates. In order to simplify the inputting of data, all variables are initialized to "default" values by the program. The default values are indicated on the input data specification sheet. If input data is omitted for a variable, the program will use the default value. Therefore, if the input data for a variable corresponds to the default value for that variable, it is not necessary to input the data to the program.

The input data sheets contain the Fortran name of each of the input variables and space for the input data. The input data system utilizes the Fortran "NAMELIST" feature. This feature requires that the name of each variable be input along with an equal sign and then the data. Each data term must be followed by a comma. This is all taken care of

by the input data sheet as well as the variations for integer and real variables. It is only necessary to place the input data in the appropriate spaces on the data sheets and thence to keypunch one card (and continuations if necessary) for each row shown on the data sheets. Everything in the ruled boxes is to be keypunched.

INPUT DATA SPECIFICATION (SATIL 2)

VARIABLE NAME	DEFINITION	RANGE	DEFAULT VALUE
1. MAXN	Number of time periods (years) to be considered.	1-15	1
2. MAXLSC	Number of spacecraft types to be considered. A spacecraft consists of a bus, made up of a number of subsystems, and one or more sensors.	1-5	1
3. MAXLS	Number of sensor types to be considered. This is the total number of different sensors used by the MAXLSC spacecraft.	1-1Ø	1
4. MAXNB	Maximum number of spacecraft buses to be considered. A bus consists of a number of support subsystems (i.e., AVCS, TTC, power subsystem, etc.) all of which must function properly for the sensors (i.e., the payload) to be operational.	1-5	1
5. MAXLB	Maximum number of spacecraft subsystems which comprise the bus and whose reliability are to be explicitly considered.	1-5	1
6. MAXIE	Maximum number of launch system configurations to be considered. A launch system consists of a set of cost and reliability data in terms of spacecraft type.	1-1Ø	1

VARIABLE NAME		DEFINITION	RANGE	DEFAULT VALUE
7.	MAXR	Number of Monte-Carlo simulation runs to be performed (even multiples of 1ØØ). When only a single run is to be performed, enter MAXR = Ø.	Unlimited	1
8.	MAXI	Maximum number of rows to be printed in "Probability of Indicated Quantity" output table.	1-4Ø	25
9.	NOINT	Number of rows to be printed in "Probability of Indicated Costs" and "Probability of Present Value of Cost" output tables.	1-4Ø	25
1Ø.	NSEN__(N)	Number of operating sensors of type LS required in orbit in year N. Values must be specified for N $\leq$ MAXN.	Ø-1Ø	Ø for all N
11.	IMIX__(LSC)	Specification of sensors of type* LS per spacecraft type (LSC). When equal to 1, the LS sensor is on-board the LSC spacecraft. When a sensor is not on-board a specific LSC spacecraft type, the corresponding value of IMIX__ is Ø. Values must be specified for 1 $\leq$ LS $\leq$ MAXLS and 1 $\leq$ LSC $\leq$ MAXLSC.	Ø or 1	Ø for all LSC
12.	IBMIX (LSC)	Identity of the spacecraft bus* (i.e., value of NB) to be used to form the LSC spacecraft. Values must be specified for 1 $\leq$ LSC $\leq$ MAXLSC.	1-5	1 for all LSC

* The general subscript nomenclature is illustrated in Figure 3.1.

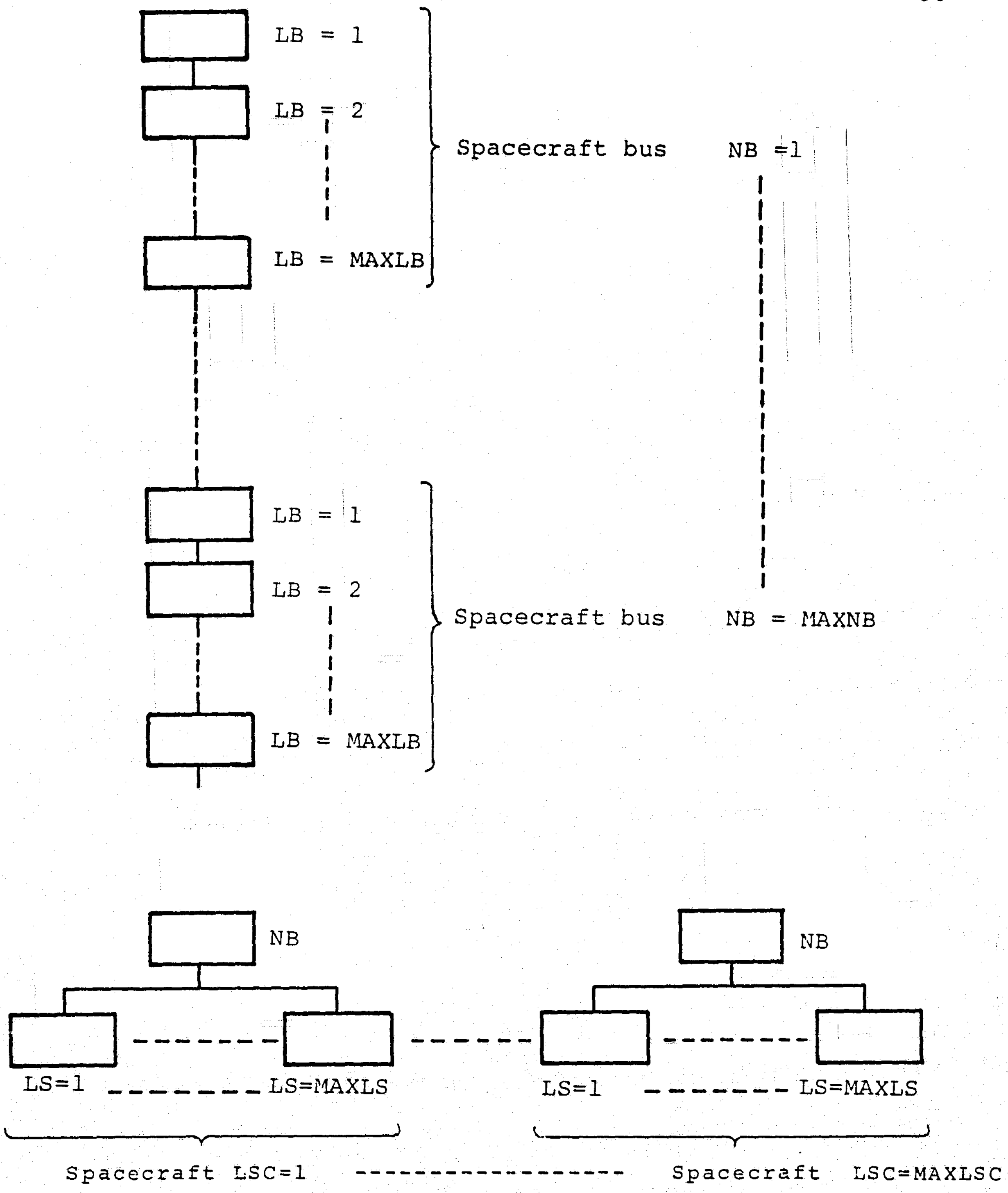


Figure 3.1 General Subscript Nomenclature

INPUT DATA SHEET

1.	MAXN =	,
2.	MAXLSC =	,
3.	MAXLS =	,
4.	MAXNB =	,
5.	MAXLB =	,
6.	MAXIE =	,

7.	MAXR =	,
8.	MAXI =	,
9.	NOINT =	,

N

		1	2	3	4	5	6	7	8	9	1Ø	11	12	13	14	15
10.	NSENØ1 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
	NSENØ2 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
	NSENØ3 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
	NSENØ4 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
	NSENØ5 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
	NSENØ6 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
	NSENØ7 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
	NSENØ8 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
	NSENØ9 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
	NSEN1Ø =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,

INPUT DATA SHEET

LSC

		1	2	3	4	5
11.	IMIXØ1 =	,	,	,	,	,
	IMIXØ2 =	,	,	,	,	,
	IMIXØ3 =	,	,	,	,	,
	IMIXØ4 =	,	,	,	,	,
	IMIXØ5 =	,	,	,	,	,
	IMIXØ6 =	,	,	,	,	,
	IMIXØ7 =	,	,	,	,	,
	IMIXØ8 =	,	,	,	,	,
	IMIXØ9 =	,	,	,	,	,
	IMIX1Ø =	,	,	,	,	,

LSC

		1	2	3	4	5
12.	IMBIX =	,	,	,	,	,

	VARIABLE NAME	DEFINITION	RANGE	DEFAULT VALUE
13.	AMTBF_(NB)	Mean time before failure (years) for random or chance failures of the LB subsystem which comprises the NB bus. Specify values for $1 \leq LB \leq MAXLB$ and $1 \leq NB \leq MAXNB$.	.Ø1-1ØØ.	5.Ø for all NB
14.	STAND_(NB)	Standard deviation (years) of the wearout life of the LB subsystem of the NB bus. Specify values for $1 \leq LB \leq MAXLB$ and $1 \leq NB \leq MAXNB$.	.Ø1-1ØØ.	Ø.5 for all NB
15.	AMEAN_(NB)	Expected or mean wearout life (years) of the LB subsystem of the NB bus. Specify values for $1 \leq LB \leq MAXLB$ and $1 \leq NB \leq MAXNB$.	.Ø1-1ØØ.	5.Ø for all NB
16.	AMTBS (LS)	Mean time before failure (years) for random or chance failures of the LS sensor. Specify for $1 \leq LS \leq MAXLS$.	.Ø1-1ØØ.	5.Ø for all LS
17.	STANDS (LS)	Standard deviation (years) of the wearout life of the LS sensor. Specify for $1 \leq LS \leq MAXLS$.	.Ø1-1ØØ.	5.Ø for all LS
18.	AMEANS (LS)	Expected or mean wearout life (years) of the LS sensor. Specify for $1 \leq LS \leq MAXLS$.	.Ø1-1ØØ.	5.Ø for all LS

INPUT DATA SHEET

NB

		1	2	3	4	5
13.	AMTBF1=	. ,	. ,	. ,	. ,	. ,
	AMTBF2=	. ,	. ,	. ,	. ,	. ,
	AMTBF3=	. ,	. ,	. ,	. ,	. ,
	AMTBF4=	. ,	. ,	. ,	. ,	. ,
	AMTBF5=	. ,	. ,	. ,	. ,	. ,

14.	STAND1=	. ,	. ,	. ,	. ,	. ,
	STAND2=	. ,	. ,	. ,	. ,	. ,
	STAND3=	. ,	. ,	. ,	. ,	. ,
	STAND4=	. ,	. ,	. ,	. ,	. ,
	STAND5=	. ,	. ,	. ,	. ,	. ,

15.	AMEAN1=	. ,	. ,	. ,	. ,	. ,
	AMEAN2=	. ,	. ,	. ,	. ,	. ,
	AMEAN3=	. ,	. ,	. ,	. ,	. ,
	AMEAN4=	. ,	. ,	. ,	. ,	. ,
	AMEAN5=	. ,	. ,	. ,	. ,	. ,

LS

		1	2	3	4	5	6	7	8	9	1Ø
16.	AMTBS=	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
17.	STANDS=	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
18.	AMEANS=	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,

VARIABLE NAME	DEFINITION	RANGE	DEFAULT VALUE
19. AMAXC (LS)	Maximum estimated unit cost (10^6 $) of the LS sensor. This establishes the upper limit for the range of cost uncertainty. Specify for $1 \le LS \le MAXLS$.	.0-1000.	.0 for all LS
20. AMINC (LS)	Minimum estimated unit cost (10^6 $) of the LS sensor. This establishes the lower limit for the range of cost uncertainty. Specify for $1 \le LS \le MAXLS$.	.0-1000.	.0 for all LS
21. IPT (LS)	Name of the uncertainty profile* (i.e., probability density function) to be associated with the range of uncertainty established by AMAXC and AMINC for the LS sensor. This establishes the subjective probability distribution of cost. Typical uncertainty profiles are illustrated (see Figure 2-2) and may be modified by changing values of PPP. Specify for $1 \le LS \le MAXLS$.	1-30	16 for all LS
22. CALC (LS)	Cumulative average learning rate (%) for the LS sensor. Assumes that costs are reduced by 100.-CALC percent every time the number of years from first use doubles. Specify for $1 \le LS \le MAXLS$.	.01-100	90 for all LS

* The default uncertainty profiles are illustrated in Figure 2-2.

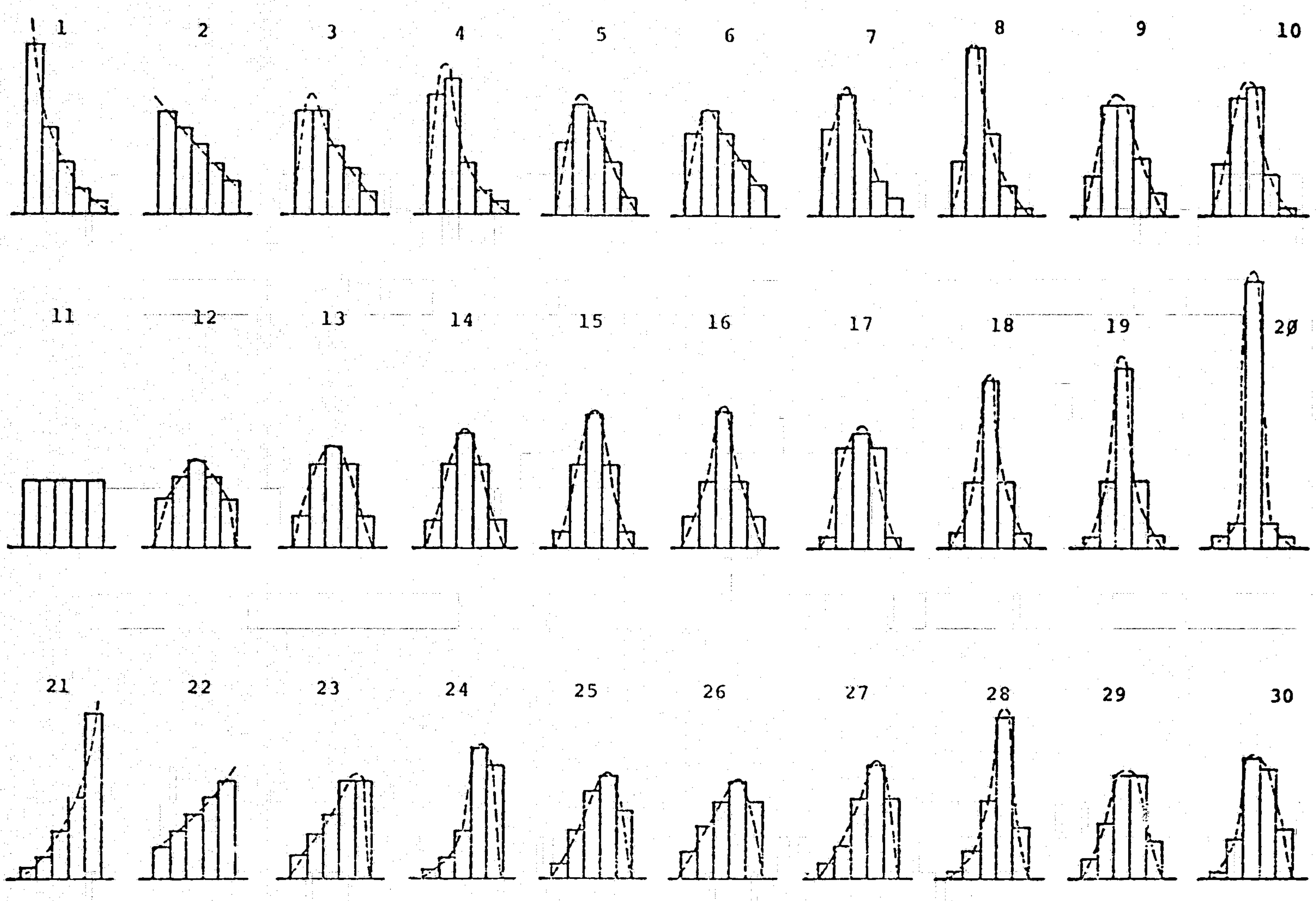


Figure 3.2 Uncertainty Profiles

INPUT DATA SHEET

LS

		1	2	3	4	5	6	7	8	9	1Ø	11	12	13	14	15
19.	AMAXC=	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
2Ø.	AMINC=	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
21.	IPT =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
22.	CALC =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,

NB

		1	2	3	4	5
23.	AMAXB=	. ,	. ,	. ,	. ,	. ,
24.	AMINB=	. ,	. ,	. ,	. ,	. ,
25.	IPTB =	,	,	,	,	,
26.	CALB =	. ,	. ,	. ,	. ,	. ,

27.	AMAXM=	. ,
28.	AMINM=	. ,
29.	IPTM =	. ,
3Ø.	CALR =	. ,

VARIABLE NAME		DEFINITION	RANGE	DEFAULT VALUE
23.	AMAXB (NB)	Maximum estimated unit cost (10^{6} $) of the NB spacecraft bus. This establishes the upper limit for the range of cost uncertainty. Specify for $1 \leq NB \leq MAXNB$.	.Ø-1ØØØ.	.Ø for all NB
24.	AMINB (NB)	Minimum estimated unit cost (10^{6} $) of the NB spacecraft bus. This establishes the lower limit for the range of cost uncertainty. Specify for $1 \leq NB \leq MAXNB$.	.Ø-1ØØØ.	.Ø for all NB
25.	IPTB (NB)	Name of the uncertainty profile (i.e., probability density function) to be associated with the range of uncertainty by AMAXB and AMINB for the NB spacecraft bus. Specify for $1 \leq NB \leq MAXNB$. (See IPT (LS)).	1-3Ø	16 for all NB
26.	CALB (NB)	Cumulative average learning rate (%) for the NB spacecraft bus. Assumes that costs are reduced by 1ØØ.-CALB percent every time the number of years from first use doubles. Specify for $1 \leq NB \leq MAXNB$.	.Ø1-1ØØ.	9Ø. for all NB

VARIABLE NAME	DEFINITION	RANGE	DEFAULT VALUE
27. AMAXM	Maximum estimated spacecraft refurbishment and maintenance cost expressed as a percentage of total spacecraft (including bus and sensors) cost. This estabishes the upper limit for the range of cost uncertainty.	.Ø-1ØØ.	.Ø
28. AMINM	Minimum estimated spacecraft refurbishment and maintenance cost expressed as a percentage of total spacecraft (including bus and sensors) cost. This establishes the lower limit for the range of cost uncertainty.	.Ø-1ØØ.	.Ø
29. IPTB	Name of the uncertainty profile (i.e. probability density function) to be associated with the range of uncertainty by AMAXM and AMINM. (see IPT (LS)).	1-3Ø	16
30. CALR	Cumulative average learning rate (%) for the spacecraft refurbishment and maintenance cost. Assumes that costs are reduced by 1ØØ-CALR percent every time the number of years from first use doubles.	.Ø1-1ØØ.	9Ø.

VARIABLE NAME	DEFINITION	RANGE	DEFAULT VALUE
31. AMXLC_(IE)	Maximum estimated launch cost ($1Ø^6$ $) for the LSC spacecraft with the IE launch system. This establishes the upper limit for the range of cost uncertainty. Specify for 1 ≤ IE ≤ MAXIE.	.Ø-1ØØØ.	.Ø for all IE
32. AMNLC_(IE)	Minimum estimated launch cost ($1Ø^6$ $) for the LSC spacecraft with the IE launch system. Specify for 1 ≤ IE ≤ MAXIE.	.Ø-1ØØØ.	.Ø for all IE
33. IPTLC_(IE)	Name of the uncertainty profile (i.e., probability density function) to be associated with the range of uncertainty by AMXLC_ and AMNLC_ for the IE launch system. Specify 1 ≤ IE ≤ MAXIE.	1-3Ø	16 for all IE
34. CALLC_(IE)	Cumulative average learning rate (%) for launching the LSC spacecraft with the IE launch system. Assumes that costs are reduced by 1ØØ.-CALLC_ percent every time the number of years from first use doubles. Specify for 1 ≤ IE ≤ MAXIE.	.Ø1-1ØØ.	9Ø. for all NB
35. LNCHS_(N)	The name of the launch system (value of IE) to be used in year N for launching the LCS spacecraft. Specify for 1 ≤ N ≤ MAXN.	1-1Ø	1 for all N

INPUT DATA SHEET

IE

		1	2	3	4	5	6	7	8	9	1Ø
31.	AMXLC1 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
32.	AMNLC1 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
33.	IPTLC1 =	,	,	,	,	,	,	,	,	,	,
34.	CALLC1 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,

AMXLC2 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
AMNLC2 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
IPTLC2 =	,	,	,	,	,	,	,	,	,	,
CALLC2 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,

AMXLC3 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
AMNLC3 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
IPTLC3 =	,	,	,	,	,	,	,	,	,	,
CALLC3 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,

INPUT DATA SHEET

AMXLC4 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
AMNLC4 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
IPTLC4 =	,	,	,	,	,	,	,	,	,	,
CALLC4 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,

AMXLC5 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
AMNLC5 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
IPTLC5 =	,	,	,	,	,	,	,	,	,	,
CALLC5 =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,

N

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
35. LNCHS1 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
LNCHS2 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
LNCHS3 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
LNCHS4 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,
LNCHS5 =	,	,	,	,	,	,	,	,	,	,	,	,	,	,	,

VARIABLE NAME	DEFINITION	RANGE	DEFAULT VALUE
36. ORBCAP (LSC)	Indicator of Orbiter capability for placing the LSC payload directly into the desired orbit. When ORBCAP = Y it is implied that the orbiter is capable of placing the payload into the desired orbit. When ORBCAP $\neq$ Y it is implied that a "space tug" or upper stage is required. Specify for $1 \leq LSC \leq MAXLSC$.	Y or N	N for all LSC
37. PPS (LSC)	Probability of the LSC spacecraft functioning properly when placed in final desired orbit (wear-in period). Specify for $1 \leq LSC \leq MAXLSC$.	.Ø-1.ØØ	1.ØØ for all LSC
38. PBS (IE)	Probability of a booster success per launch for the IE launch system. Specify for $1 \leq IE \leq MAXIE$.	.Ø-1.ØØ	1.ØØ for all IE
39. PBRS (IE)	Probability of a booster recovery given a booster launch success. Specify for $1 \leq IE \leq MAXIE$.	.Ø-1.ØØ	1.ØØ for all IE
4Ø. PBRF (IE)	Probability of a booster recovery given a booster failure or malfunction. Specify for $1 \leq IE \leq MAXIE$.	.Ø-1.ØØ	1.ØØ for all IE
41. POS (IE)	Probability of an orbiter success (i.e., no abort prior to placing spacecraft and/or upper stage and spacecraft in orbit). Specify for $1 \leq IE \leq MAXIE$.	.Ø-1.ØØ	1.ØØ for all IE

VARIABLE NAME	DEFINITION	RANGE	DEFAULT VALUE
42. POROF (IE)	Probability of an orbiter recovery given an orbiter abort. Specify for 1 ≤ IE ≤ MAXIE.	.Ø-1.ØØ	1.ØØ for all IE
43. PORBF (IE)	Probability of an orbiter recovery given a booster launch failure. Specify for 1 ≤ IE ≤ MAXIE.	.Ø-1.ØØ	1.ØØ for all IE
44. POR (IE)	Probability of an orbiter recovery given an otherwise successful flight. Specify for 1 ≤ IE ≤ MAXIE.	.Ø-1.ØØ	1.ØØ for all IE
45. PPMO (IE)	Probability of propulsion module (space tug or other upper stage) checking out successfully (wear-in period) prior to leaving vicinity of orbiter. Specify for 1 ≤ IE ≤ MAXIE.	.Ø-1.ØØ	1.ØØ for all IE
46. PPMP (IE)	Probability of propulsion modules (space tug or other upper stage) transferring to and placing spacecraft in desired orbit. Specify for 1 ≤ IE ≤ MAXIE.	.Ø-1.ØØ	1.ØØ for all IE
47. PPMRP (IE)	Probability of propulsion module (space tug or other upper stage) successfully returning and rendezvousing with the orbiter. Specify for 1 ≤ IE ≤ MAXIE.	.Ø-1.ØØ	1.ØØ for all IE
48. PPLRR (IE)	Probability that a spacecraft which does not check out successfully in terminal orbit is reacquired by the propulsion module (space tug or other upper stage) for return to low earth orbit. Specify for 1 ≤ IE ≤ MAXIE.	.Ø-1.ØØ	1.ØØ for all IE

VARIABLE NAME	DEFINITION	RANGE	DEFAULT VALUE
49. MAXM (LSC)	Maximum number of spacecraft of type LSC which will be operational at any point in time.	1-2Ø	1Ø
50. NN	Number of time periods to be considered for the optimization of spacecraft launch schedule.	1-MAXN	5
51. DR	Discount rate, expressed as a percentage, used in the present value of cost computations.	.Ø-1ØØ.	1Ø.Ø
52. DETC	If it is desired to have detailed cost reports (i.e., costs by spacecraft type) printed then DETC = 'Y'.	Y or N	N
53. PPA__(IA)	Uncertainty profile data; i.e., probability associated with the IA interval of profile IB where $1 \le IA \le 5$ and $1 \le IB \le 2Ø$.	.Ø-1.ØØ	See Table 3.1.

INPUT DATA SHEET

LSC

		1	2	3	4	5
36.	ORBCAP =	' ' ,	' ' ,	' ' ,	' ' ,	' ' ,
37.	PPS =	. ,	. ,	. ,	. ,	. ,

IE

		1	2	3	4	5	6	7	8	9	1Ø
38.	PBS =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
39.	PBRS =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
4Ø.	PBRF =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
41.	POS =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
42.	POROF =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
43.	PORBF =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
44.	POR =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
45.	PPMO =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
46.	PPMP =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
47.	PPMRP =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,
48.	PPLRR =	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,	. ,

LSC

		1	2	3	4	5
49.	MAXM =	,	,	,	,	,

5Ø.	NN =	,
51.	DR =	. ,

52.	DETC =	' ' ,

INPUT DATA SHEET

		IA				
		1	2	3	4	5
53.	PPPØ1 =	. ,	. ,	. ,	. ,	. ,
	PPPØ2 =	. ,	. ,	. ,	. ,	. ,
	PPPØ3 =	. ,	. ,	. ,	. ,	. ,
	PPPØ4 =	. ,	. ,	. ,	. ,	. ,
	PPPØ5 =	. ,	. ,	. ,	. ,	. ,
	PPPØ6 =	. ,	. ,	. ,	. ,	. ,
	PPPØ7 =	. ,	. ,	. ,	. ,	. ,
	PPPØ8 =	. ,	. ,	. ,	. ,	. ,
	PPPØ9 =	. ,	. ,	. ,	. ,	. ,
	PPP1Ø =	. ,	. ,	. ,	. ,	. ,
	PPP11 =	. ,	. ,	. ,	. ,	. ,
	PPP12 =	. ,	. ,	. ,	. ,	. ,
	PPP13 =	. ,	. ,	. ,	. ,	. ,
	PPP14 =	. ,	. ,	. ,	. ,	. ,
	PPP15 =	. ,	. ,	. ,	. ,	. ,
	PPP16 =	. ,	. ,	. ,	. ,	. ,
	PPP17 =	. ,	. ,	. ,	. ,	. ,
	PPP18 =	. ,	. ,	. ,	. ,	. ,
	PPP19 =	. ,	. ,	. ,	. ,	. ,
	PPP2Ø =	. ,	. ,	. ,	. ,	. ,

Table 3.1 Initialization (Default) Values of Uncertainty Profiles

PPPXX(IA)

XX	IA 1	2	3	4	5
Ø1	.5Ø	.25	.15	.Ø7	.Ø3
Ø2	.3Ø	.25	.2Ø	.15	.1Ø
Ø3	.3Ø	.3Ø	.2Ø	.13	.Ø7
Ø4	.35	.4Ø	.15	.Ø7	.Ø3
Ø5	.21	.32	.27	.15	.Ø5
Ø6	.23	.3Ø	.23	.16	.Ø8
Ø7	.25	.35	.25	.1Ø	.Ø5
Ø8	.16	.49	.24	.Ø9	.Ø2
Ø9	.12	.32	.32	.17	.Ø7
1Ø	.15	.34	.37	.12	.Ø2
11	.2Ø	.2Ø	.2Ø	.2Ø	.2Ø
12	.15	.22	.26	.22	.15
13	.1Ø	.25	.3Ø	.25	.1Ø
14	.Ø8	.25	.34	.25	.Ø8
15	.Ø5	.25	.4Ø	.25	.Ø5
16	.1Ø	.2Ø	.4Ø	.2Ø	.1Ø
17	.Ø3	.3Ø	.34	.3Ø	.Ø3
18	.Ø5	.2Ø	.5Ø	.2Ø	.Ø5
19	.Ø3	.2Ø	.54	.2Ø	.Ø3
2Ø	.Ø3	.Ø7	.8Ø	.Ø7	.Ø3

4. MATHEMATICAL STRUCTURE

4.1 Subscript Notations

N	Time (years)
LS	Sensor type
LSC	Spacecraft type
LB	Bus subsystem identifier
IE	Launch system technology
NB	Bus type
J	Column of output data

4.2 Some Notes on Input Data

The following input data (see Chapter 3) are input in the form of linear arrays and form the indicated two-dimensional arrays.

Input Variable	Two-Dimensional Array	Comment
10. NSENXX(N)	NOSEN(LS,N)	XX is value of LS
11. IMIXXX(N)	ISMIX(LS,LSC)	XX " " " LS
13. AMTBFZ(NB)	AMTBF(LB,NB)	Z " " " LB
14. STANDZ(NB)	STANDL(LB,NB)	Z " " " LB
15. AMEANZ(NB)	AMEANL(LB,NB)	Z " " " LB
31. AMXLCY(IE)	AMAXLC(LSC,IE)	Y " " " LSC
32. AMNLCY(IE)	AMINLC(LSC,IE)	Y " " " LSC
33. IPTLCY(IE)	IPTLC(LSC,IE)	Y " " " LSC
34. CALLCY(IE)	CALLC(LSC,IE)	Y " " " LSC
35. LNCHSY(N)	LNCHS(LSC,N)	Y " " " LSC
52. PPPXX(IA)	PPP(IA,IB)	XX " " " IB

4.3 List of Variables

The following is a list of the variables used in the mathematical formulation of the SATIL 2 program. The * indicates input data variables, and the + indicates integer variables. The computed variables are defined by the equations and operations indicated in the computation functional flow given in Section 4.5.

	RELS(LS,N)	*	AMAXLC(LSC,IE)	+	NOOP(LS,N)
	PFS(LS,N)	*	AMINLC(LSC,IE)	+	NOSA(LSC,N)
	RELB(NB,N)	+*	IPTLC(LSC,IE)	+	IS(LSC,M)
+*	MAXLB		LCELC(LSC,IE)	+	ISS(LS,LSC,M)
*	AMTBF(LB)	*	CALLC(LSC,IE)	+	IYEAR(LSC,M)
*	STANDL(LB)		RANGLC(LSC,IE)	+	NFAIL(LSC)
*	AMEANL(LB)		UCPLC(I,LSC,IE)	+	ILA(LSC,N)
*	AMTBS(LS)		SCCST(LSC,N)	*	PBS(IE)
*	STANDS(LS)		UCLC(LSC,IE)	*	PBRF(IE)
*	AMEANS(LS)	+	ITS(LS)	+	IBR(LSC,N)
+*	MAXLS		PVF(N)	+	IB(LSC,N)
+*	MAXN	*	DR	+	IPL(LSC,N)
	LCE(LS)	+	IX(LSC)	*	POROF(IE)
*	CALC(LS)	+	ITL	+	IOR(LSC,N)
+*	MAXIE	+*	LNCHS(LSC,N)	+	IO(LSC,N)
+*	NN	+	IXB(NB)	*	ORBCAB(LSC)
	PFB(NB,N)	+	IN	*	IPM(LSC,N)
*	AMAXC(LS)		LCST(LSC,N)	*	PBRS(IE)
*	AMINC(LS)		LCER	*	POS(IE)
	RANGE(LS)	*	CALR	*	POROF(IE)
+*	IPT(LS)		LCEB(NB)	+	IPM(LSC,N)
	UCP(I,LS)	*	CALB(NB)	*	PPS(IE)
*	PPP(IA,IB)	+	NOSSC(LSC)	*	POR(IE)
+*	MAXB	*	AMAXB(NB)	+	IPLR(LSC,N)
+*	MAXNB	*	AMINB(NB)	*	PPMO(IE)
	ACC		RANGEB(NB)	+	IPMR(LSC,N)
	RN	+*	IPTB(NB)	*	PPMP(IE)
	UC(LS)		UCPB (I,NB)	*	PPLRR(IE)
+*	MAXR	*	AMAXM	*	PPMRP(IE)
+*	MAXI	*	AMINM		C(K,LSC,N,NR)
+*	NOINT	+*	IPTM		SUMC(K,LSC,N)
+*	ISMIX(LS, LSC)		UCPM(I)		SUMSC(K,LSC,N)
+*	MAXLSC		UCB(NB)		CT(K,N,NR)
+*	NOSEN(LS,N)		UCM		SUMCT(K,N)

	SUMJ(J,N)		RANGEM		SUMSCT(K,N)
	SUMSJ(J,N)	+*	IBMIX(LSC)		PE(II,J,N)
	ANPV(NR)		SUMPV		SUMSPV
	SUMLA(LSC,N)		SUMSLA(LSC,N)		PLA(II.LSC.N)
	SUMPL(LSC,N)		CSTIT(K)		MT(K,N)
	SUMSPL(LSC,N)		PT(K,L,N)		STDT(K,N)
	PPL(II,LSC,N)		PVX		MLA(LSC,N)
*	DETC		PVN		STDLA(LSC,N)
	AMX(K,LSC)		PVI		MPL(LSC,N)
	AMN(K,LSC)		PPV(L)		STDPL(LSC,N)
	CSTI(K,LSC)		MCST(K,LSC,N)		MPV
	P(K,LSC,L,N)		STDCST(K,LSC,N)		STDPV
	AMXT(K)		ME(J,N)	+	NOS(LSC,N)
	AMT(K)		STDE(J,N)		

* Integer

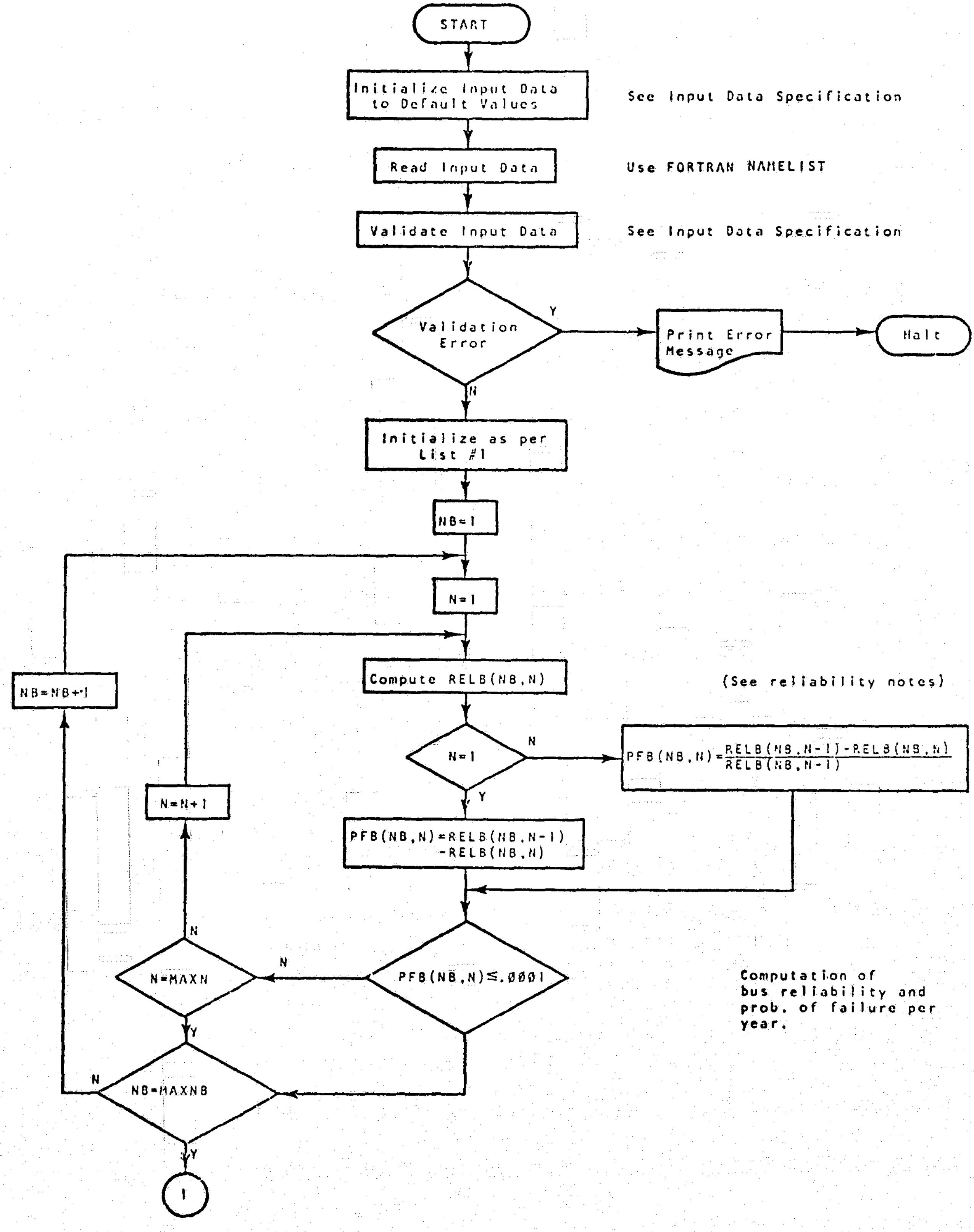
\+ Input Data

4.4 Initialization Data

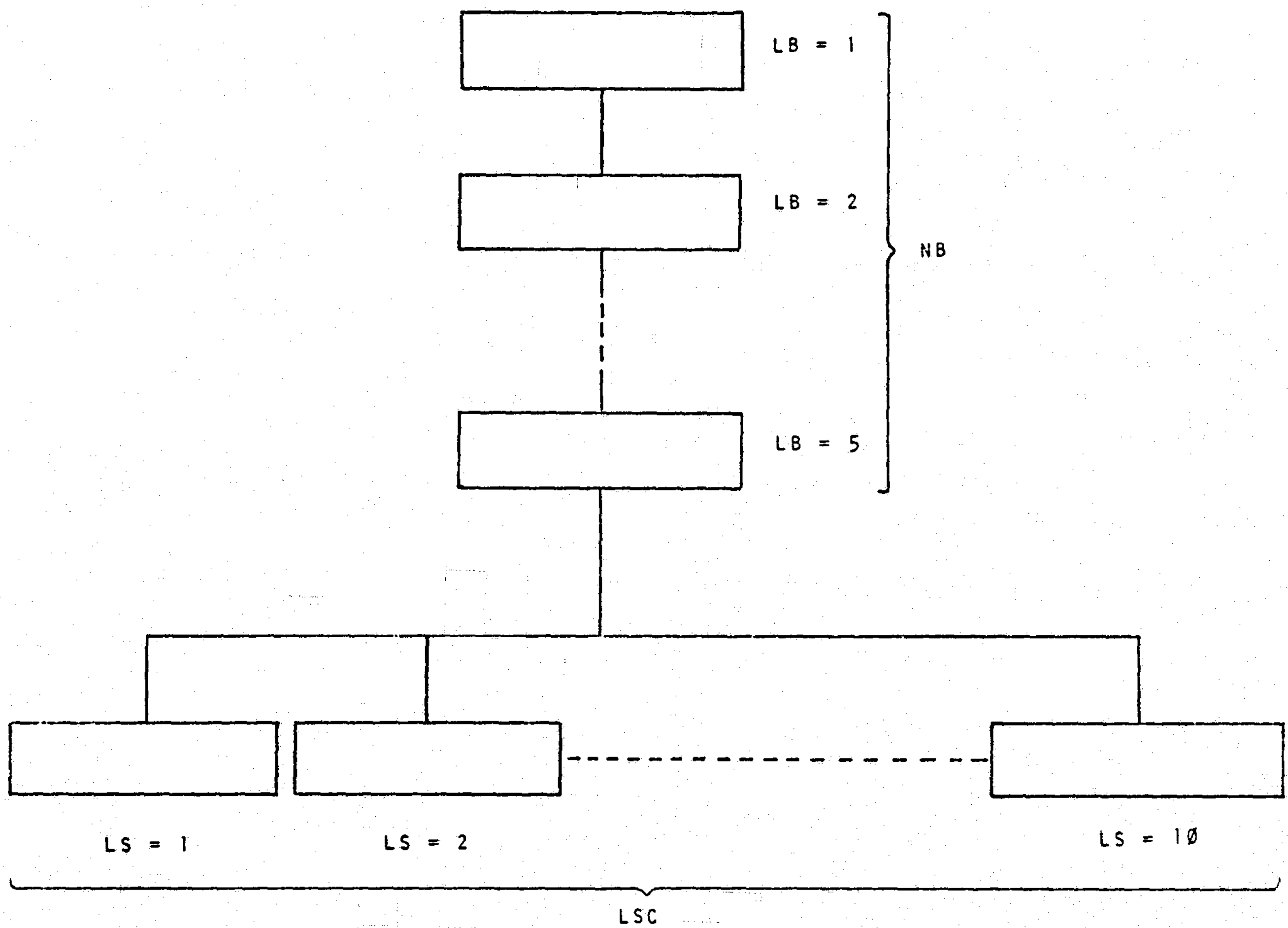
Initialization of the following variables to the indicated values takes place both inside and outside of the Monte Carlo loop. List 1 refers to data initialized prior to entering the Monte Carlo loop, and List 2 refers to initialization after entering the Monte Carlo loop.

List 1:	RELS(LS,Ø)	= 1.Ø	for all LS
	RELB(NB,Ø)	= 1.Ø	for all NB
	PFS(LS,N)	= .Ø	for all LS and N
	PFB(NB,N)	= .Ø	for all NB and N
	SUMC(K,LSC,N)	= .Ø	for all K,LSC,&N (K=1,2,3)
	SUMSC(K,LSC,N)	= .Ø	for all K,LSC,&N
	MLA(LSC,N)	= .Ø	for all LSC and N
	MPL	= .Ø	
	SUMJ(J,N)	= .Ø	for all J and N
	SUMSJ(J,N)	= .Ø	for all J and N
	PE(II,J,N)	= .Ø	for all II,J and N
	SUMLA(LSC,N)	= .Ø	for all LSC and N
	SUMSLA(LSC,N)	= .Ø	for all LSC and N
	PLA(II,LSC,N)	= .Ø	for all II, LSC,&N
	SUMPL	= .Ø	for all LSC and N
	SUMSPL	= .Ø	for all LSC and N
	PPL	= .Ø	for all II, LSC,&N
	SUMPV	= .Ø	
	SUMSPV	= .Ø	
	P(K,LSC,L,N)	= .Ø	for all K,LSC,L,N
	PT(K,L,N)	= .Ø	for all K,L,N
	PPV(L)	= .Ø	for all L
	MI	= .Ø	
List 2:	SCCST(LSC,N)	= $1Ø^{1Ø}$	for all LSC and N $(1<N<MAXN+NN)$
	LCST(LSC,N)	= $1Ø^{1Ø}$	for all LSC and N $(1\le N\le MAXN+NN)$
	IS(LSC,M)	= .Ø	for all LSC and M
	NOOP(LS,N)	= .Ø	for all LS and N
	ILA(LSC,N)	= .Ø	for all LSC and N
	IB(LSC,N)	= .Ø	for all LSC and N
	IBR(LSC,N)	= .Ø	for all LSC and N
	IPL(LSC,N)	= .Ø	for all LSC and N
	IO(LSC,N)	= .Ø	for all LSC and N
	IOR(LSC,N)	= .Ø	for all LSC and N
	IPM(LSC,N)	= .Ø	for all LSC and N
	IPLR(LSC,N)	= .Ø	for all LSC and N
	IPMR(LSC,N)	= .Ø	for all LSC and N
	ISS(LS,LSC,M)	= .Ø	for all LS,LSC,M
	NFAIL(LSC,M)	= .Ø	for all LSC,M
	ANPV(NR)	= .Ø	for all NR

4.5 Computation Functional Flow Description



Reliability Notes and General Spacecraft Configuration

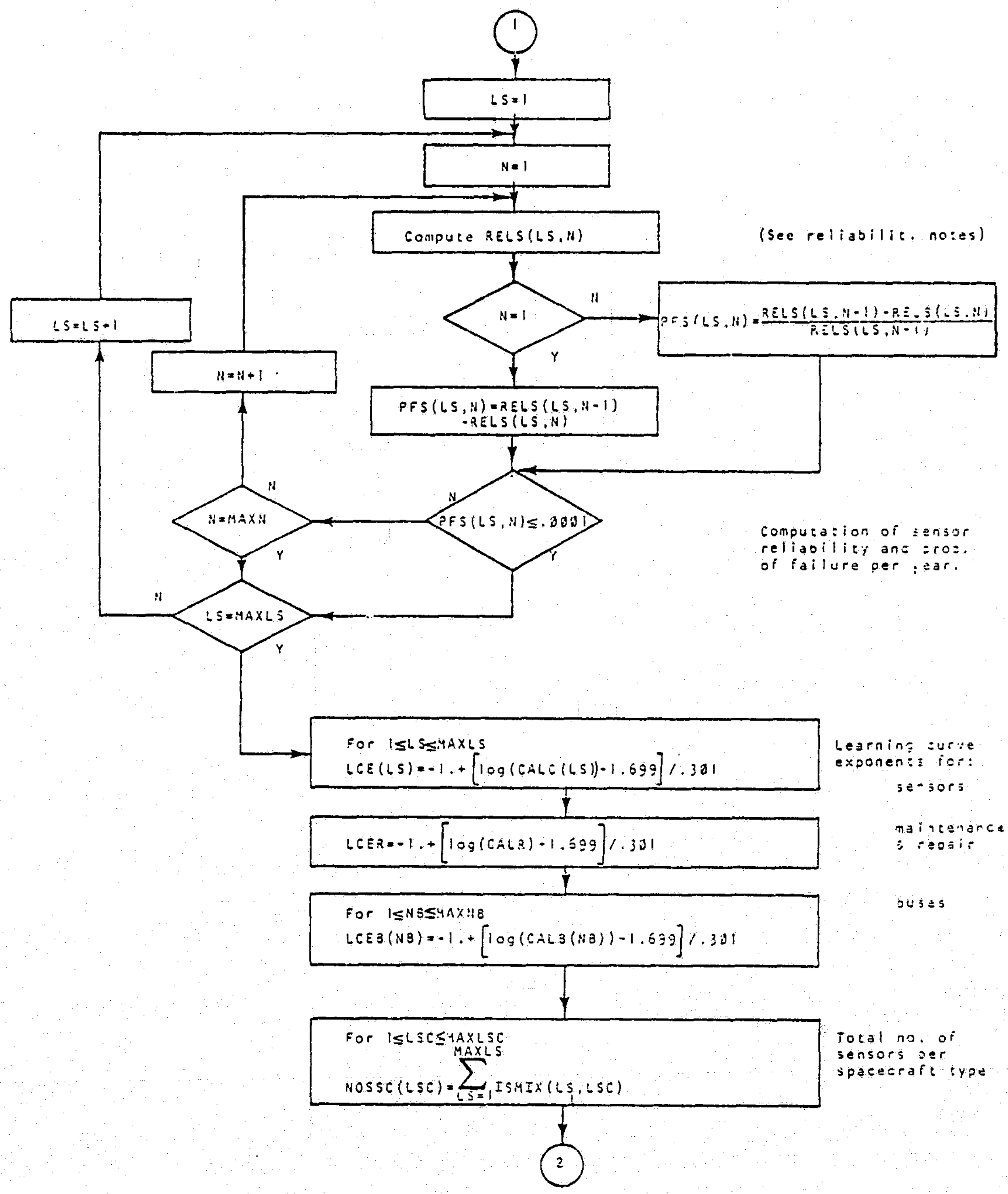


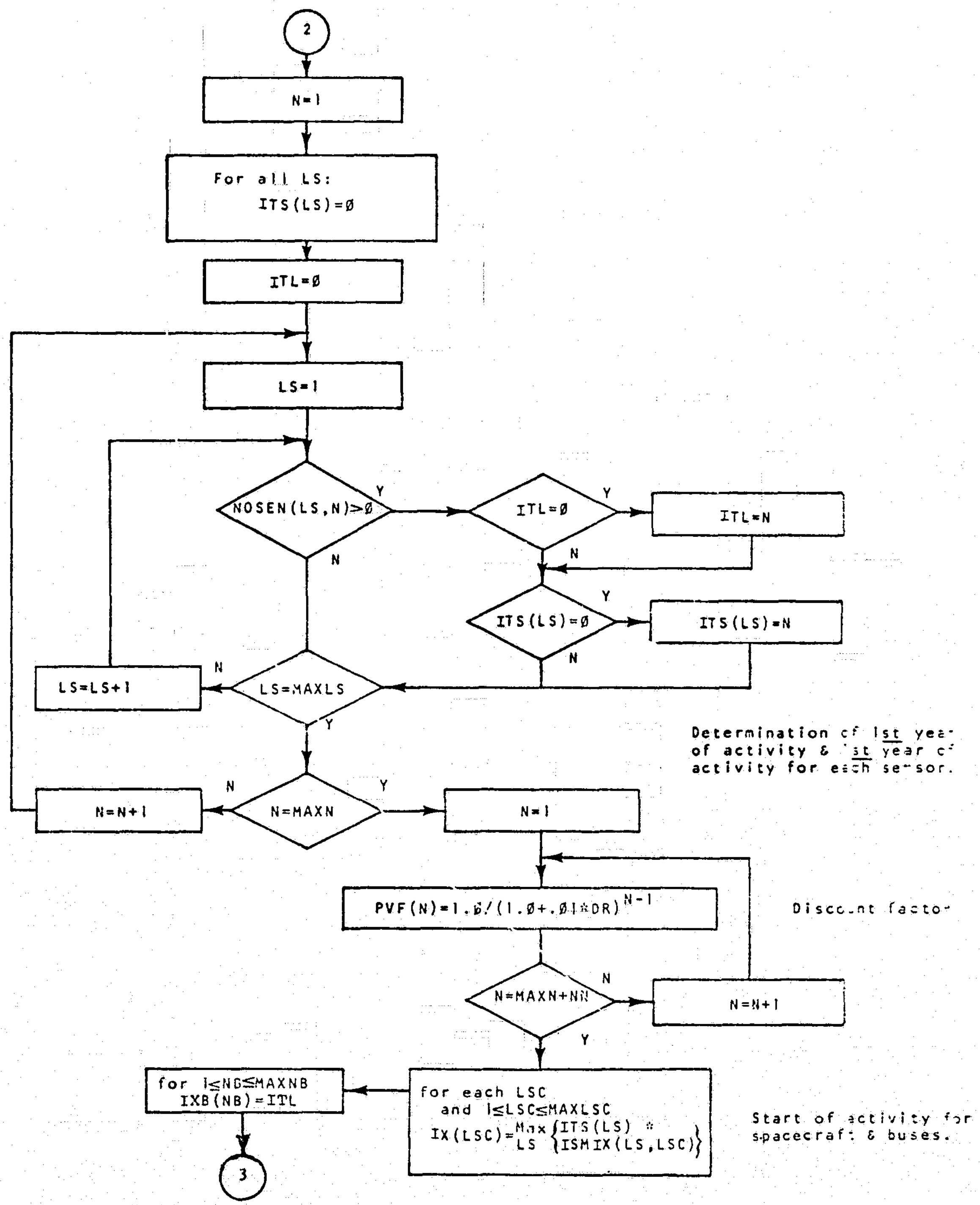
Bus Reliability: RELB(NB,N)

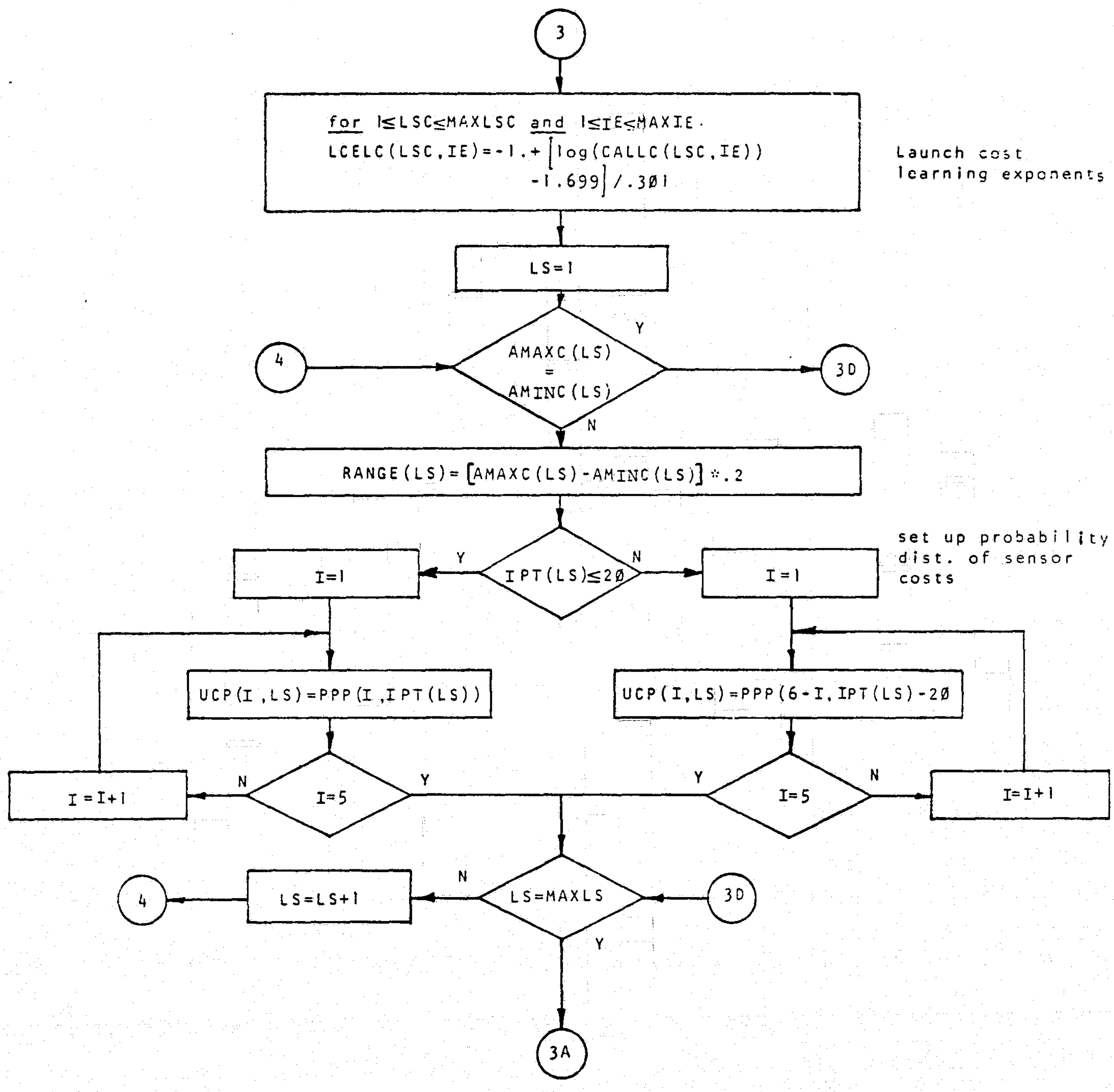
$$(1)\quad RELB(NB,N) = \prod_{LB=1}^{MAXLB} \frac{\exp\left[-N/AMTBF(LB,NB)\right]}{\sqrt{2.0\pi} * STANDL(LB,NB)} * \int_N^{\infty} \exp\left[-\frac{(x-AMEANL(LB,NB))^2}{2.0 * (STANDL(LB,NB))^2}\right] dx$$

Sensor Reliability: RELS(LS,N) Assumption is that once a sensor is placed in orbit it goes into an operational (i.e., non-dormant) mode.

$$(2)\quad RELS(LS,N) = \frac{\exp\left[-N/AMTBS(LS)\right]}{\sqrt{2.0\pi} * STANDS(LS)} * \int_N^{\infty} \exp\left[-\frac{(x-AMEANS(LS))^2}{2.0 * (STANDS(LS))^2}\right] dx$$

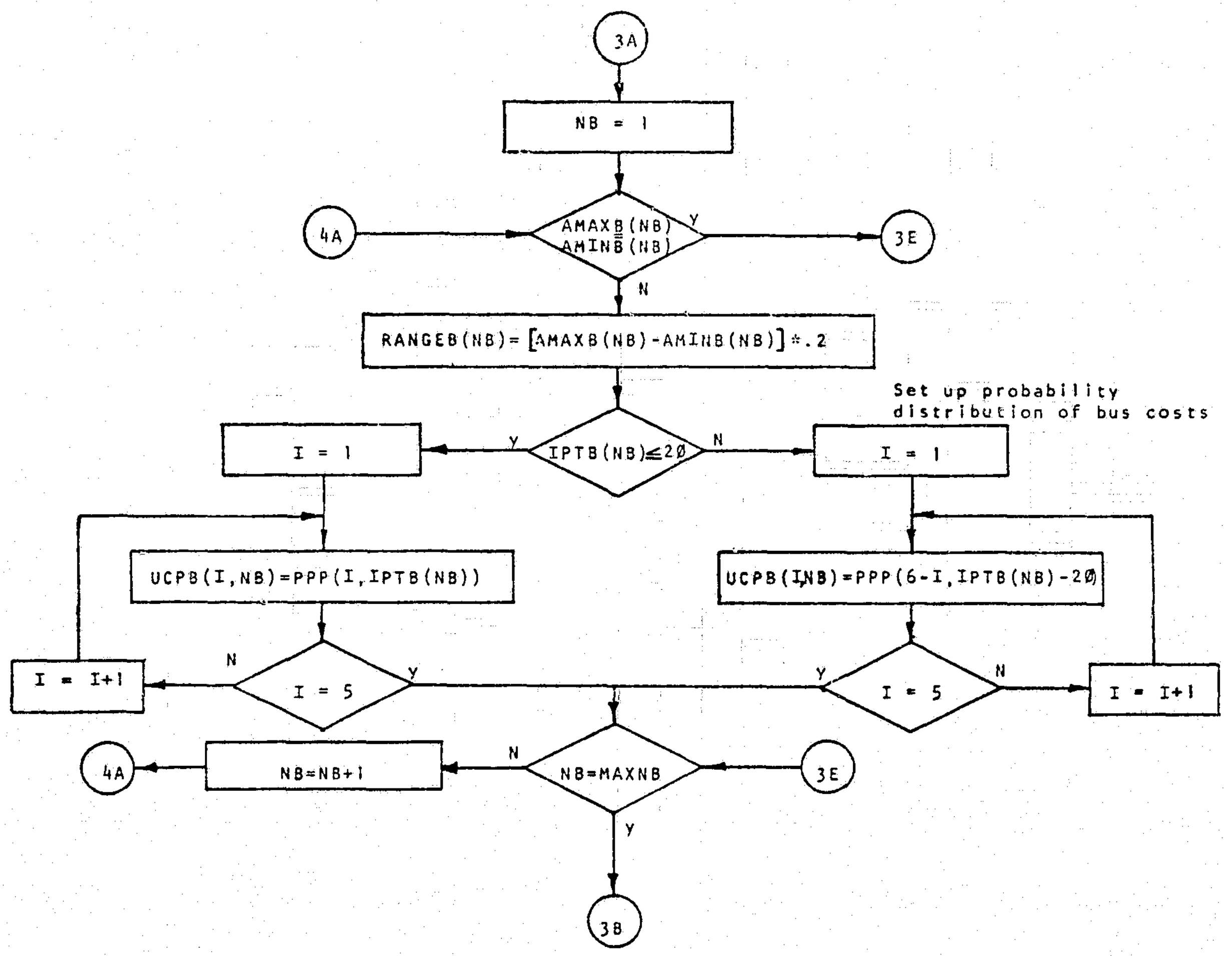

1
LS=1
N=1
Compute RELS(LS,N)
(See reliabilit. notes)
N=1
N
Y
PFS(LS,N)=RELS(LS,N-1)-RELS(LS,N)/RELS(LS,N-1)
PFS(LS,N)=RELS(LS,N-1) -RELS(LS,N)
LS=LS+1
N=N+1
N=MAXN
PFS(LS,N)≤.0001
Computation of sensor reliability and prob. of failure per year.
LS=MAXLS
For 1≤LS≤MAXLS
LCE(LS)=-1.+[log(CALC(LS))-1.699]/.301
Learning curve exponents for:
sensors
LCER=-1.+[log(CALR)-1.699]/.301
maintenance & repair
buses
For 1≤NB≤MAXNB
LCEB(NB)=-1.+[log(CALB(NB))-1.699]/.301
For 1≤LSC≤MAXLSC
NOSSC(LSC)=Σ LS=1 MAXLS ISMIX(LS,LSC)
Total no. of sensors per spacecraft type
2

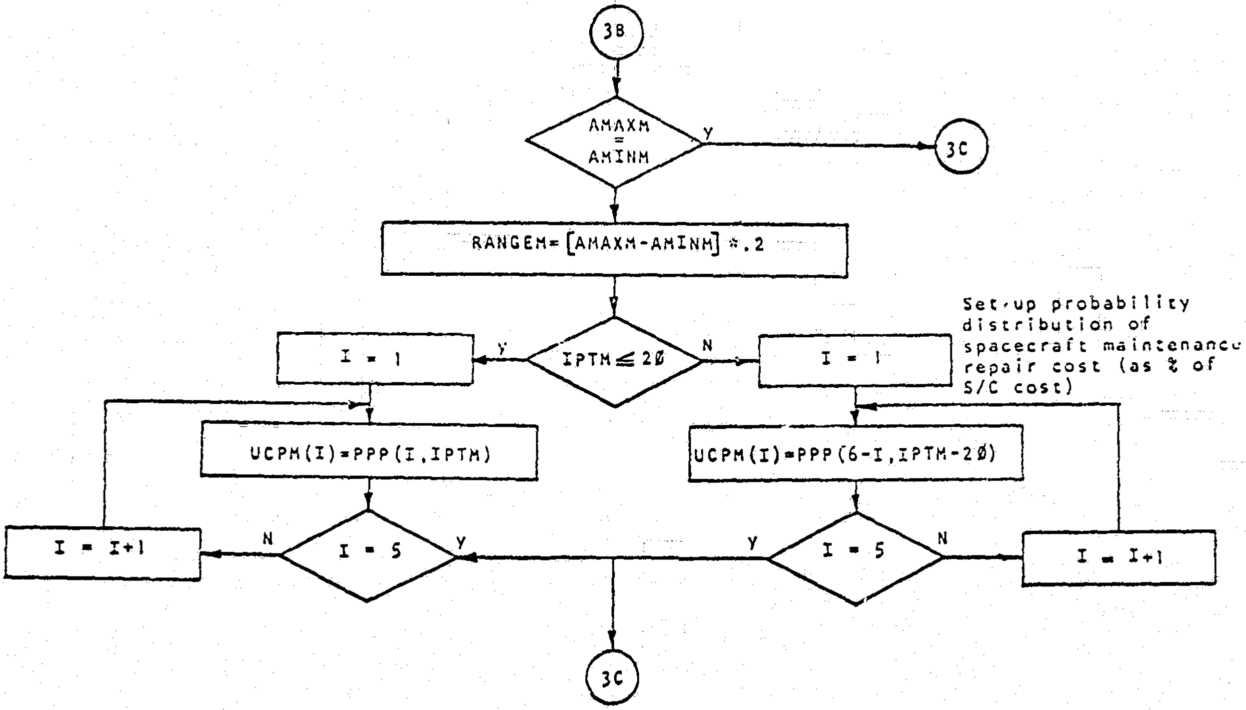

2
N=1
For all LS:
ITS(LS)=Ø
ITL=Ø
LS=1
NOSEN(LS,N)>Ø
Y
N
ITL=Ø
ITL=N
ITS(LS)=Ø
ITS(LS)=N
LS=LS+1
LS=MAXLS
Determination of 1st year of activity & 1st year of activity for each sensor.
N=N+1
N=MAXN
N=1
PVF(N)=1.Ø/(1.Ø+.Ø1*DR)^N-1
Discount factor
N=MAXN+NN
N=N+1
for 1≤NB≤MAXNB
IXB(NB)=ITL
for each LSC
and 1≤LSC≤MAXLSC
IX(LSC)=Max LS {ITS(LS) * ISMIX(LS,LSC)}
Start of activity for spacecraft & buses.
3

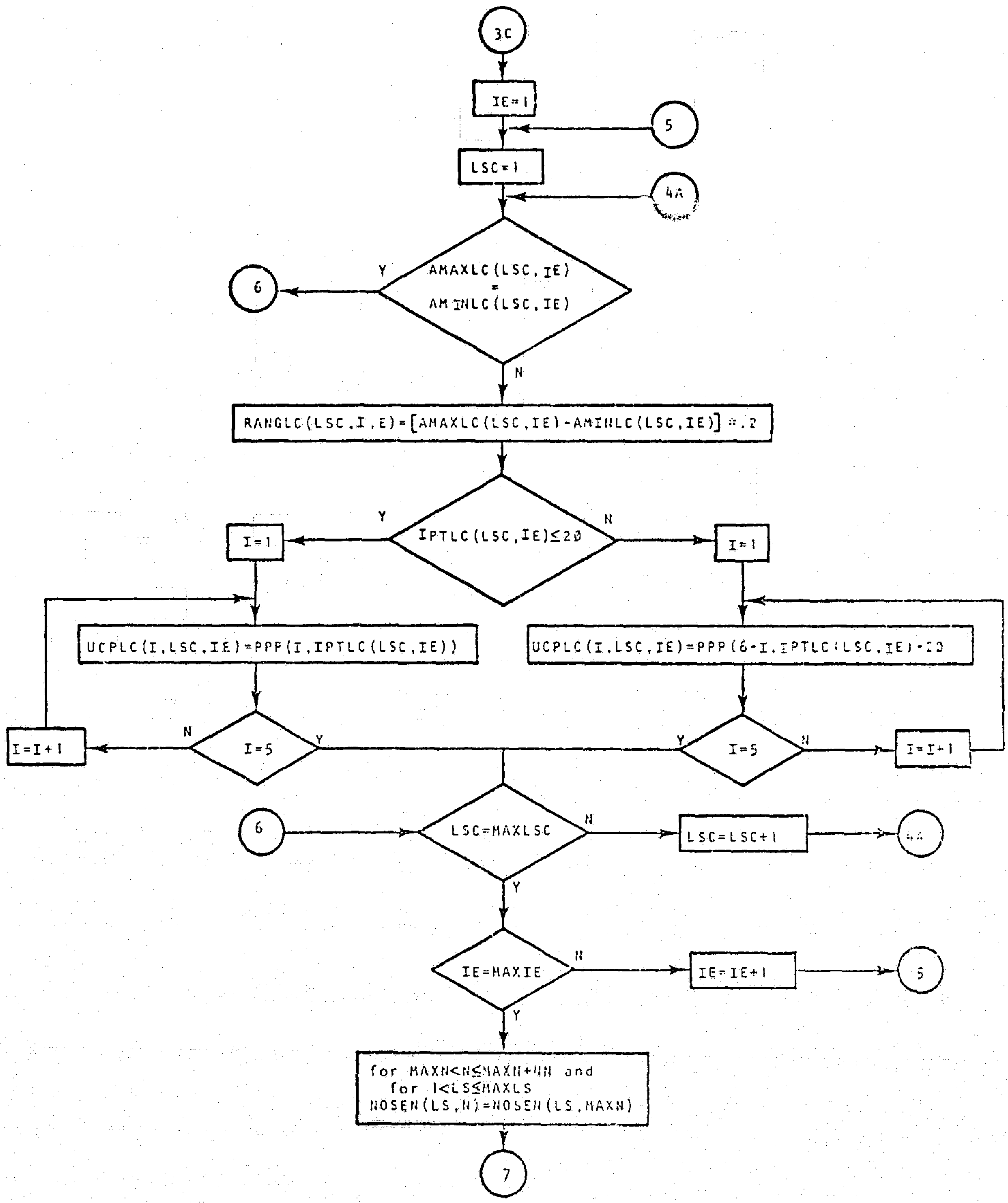


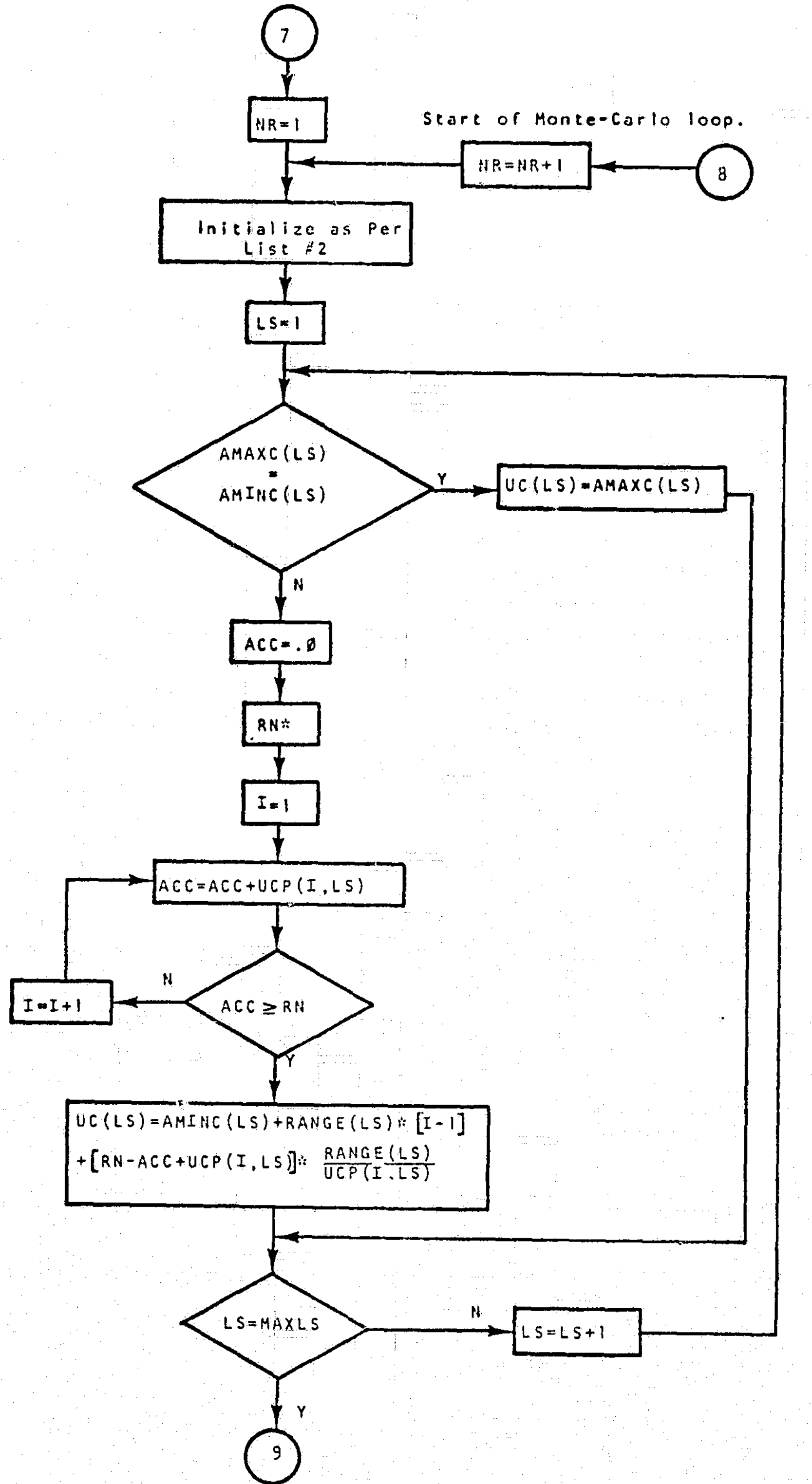
Launch cost learning exponents

set up probability dist. of sensor costs


3A
NB = 1
4A
AMAXB(NB) = AMINB(NB)
Y
3E
N
RANGEB(NB)= [AMAXB(NB)-AMINB(NB)]*.2
Set up probability distribution of bus costs
I = 1
Y
IPTB(NB)≤2Ø
N
I = 1
UCPB(I,NB)=PPP(I,IPTB(NB))
UCPB(I,NB)=PPP(6-I,IPTB(NB)-2Ø)
I = I+1
N
I = 5
Y
Y
I = 5
N
I = I+1
4A
NB=NB+1
N
NB=MAXNB
3E
Y
3B

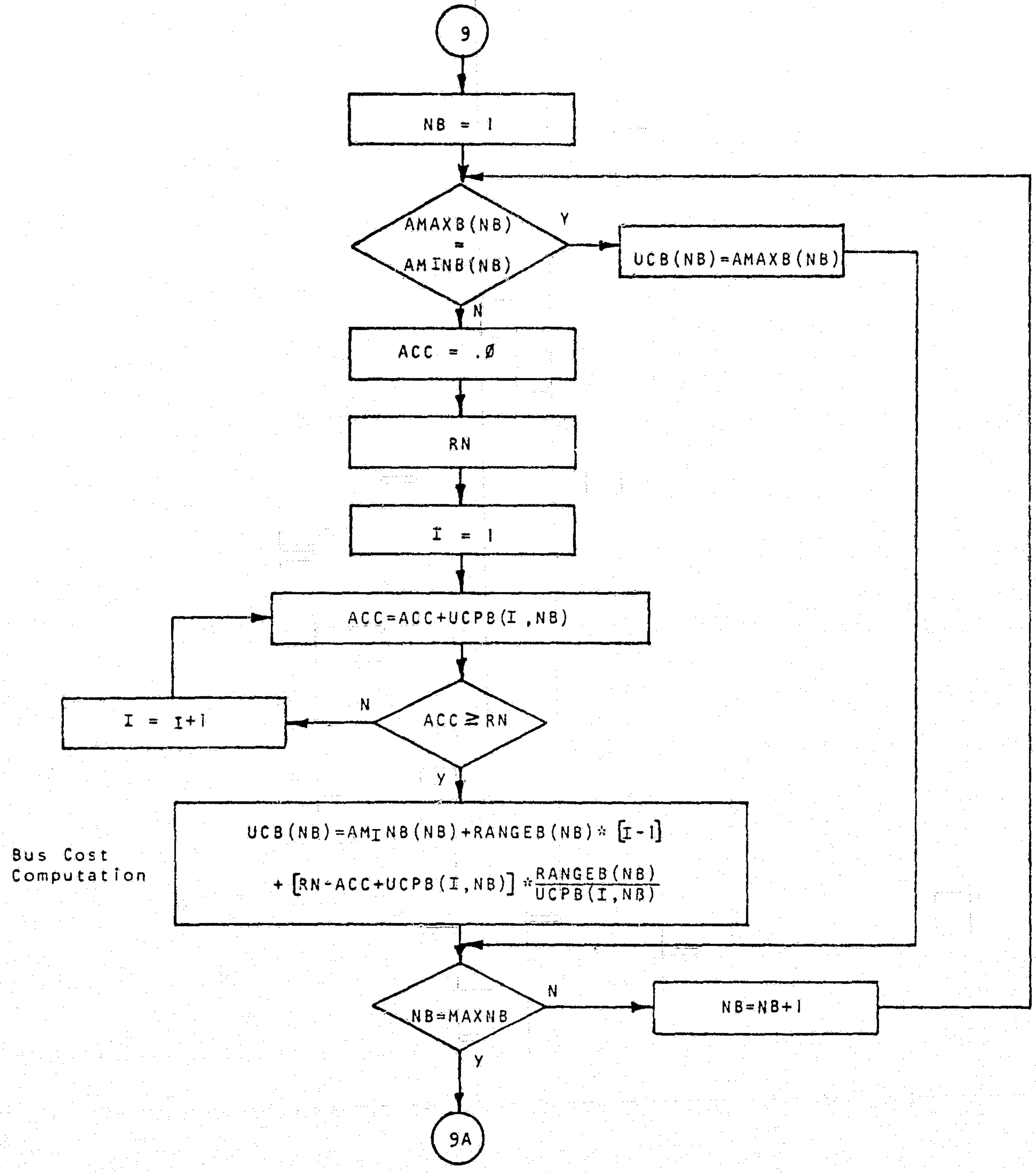

3B
AMAXM = AMINM
Y
3C
RANGEM=[AMAXM-AMINM]*.2
IPTM≤2Ø
Y
N
I = 1
I = 1
Set-up probability distribution of spacecraft maintenance repair cost (as % of S/C cost)
UCPM(I)=PPP(I,IPTM)
UCPM(I)=PPP(6-I,IPTM-2Ø)
I = I+1
N
I = 5
Y
Y
I = 5
N
I = I+1
3C

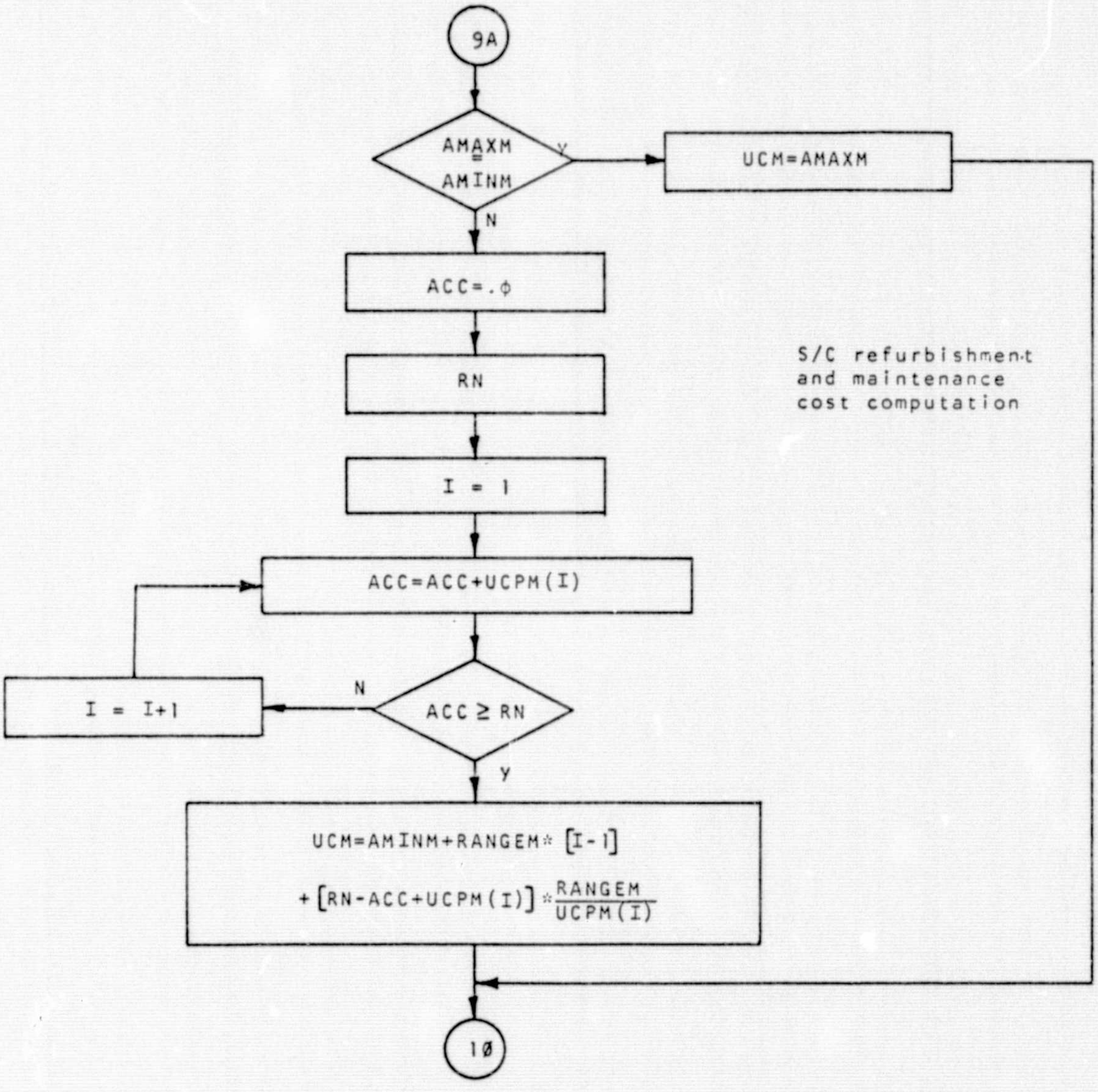

3C
IE=1
5
LSC=1
4A
AMAXLC(LSC,IE) = AMINLC(LSC,IE)
Y
6
N
RANGLC(LSC,I,E)=[AMAXLC(LSC,IE)-AMINLC(LSC,IE)]*.2
IPTLC(LSC,IE)≤20
Y
N
I=1
I=1
UCPLC(I,LSC,IE)=PPF(I,IPTLC(LSC,IE))
UCPLC(I,LSC,IE)=PPP(6-I,IPTLC(LSC,IE)-20
I=I+1
N
I=5
Y
Y
I=5
N
I=I+1
6
LSC=MAXLSC
N
LSC=LSC+1
4A
Y
IE=MAXIE
N
IE=IE+1
5
Y
for MAXN<N≤MAXN+NN and
for 1<LS≤MAXLS
NOSEN(LS,N)=NOSEN(LS,MAXN)
7



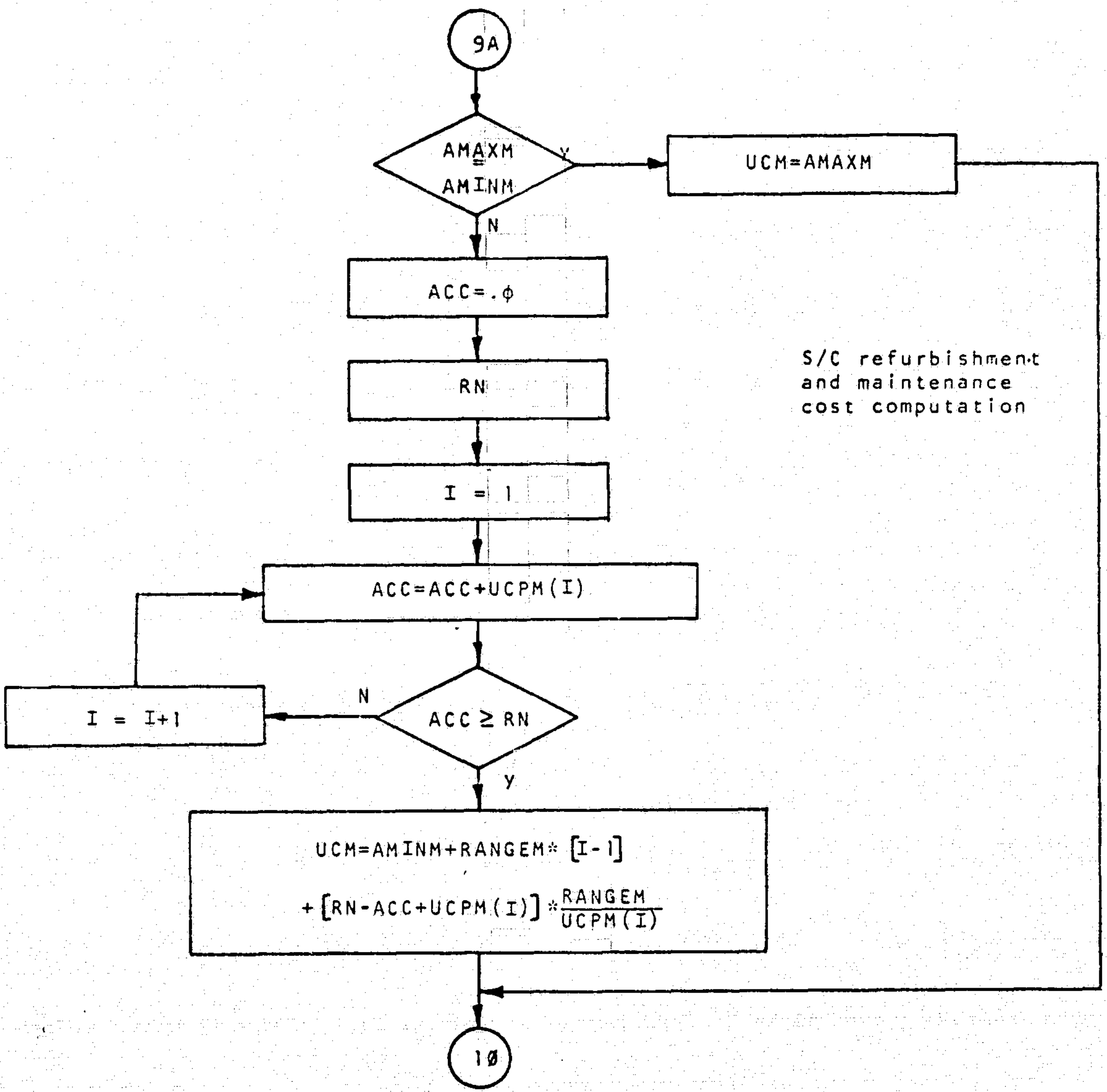
Sensor cost computation

*Note: RN implies the generation of a random number.


9
NB = 1
AMAXB(NB) = AMINB(NB)
Y
UCB(NB)=AMAXB(NB)
N
ACC = .Ø
RN
I = 1
ACC=ACC+UCPB(I,NB)
N
ACC ≥ RN
I = I+1
Y
Bus Cost Computation
UCB(NB)=AMINB(NB)+RANGEB(NB)* [I-1]
+ [RN-ACC+UCPB(I,NB)] * RANGEB(NB) / UCPB(I,NB)
N
NB=MAXNB
NB=NB+1
Y
9A

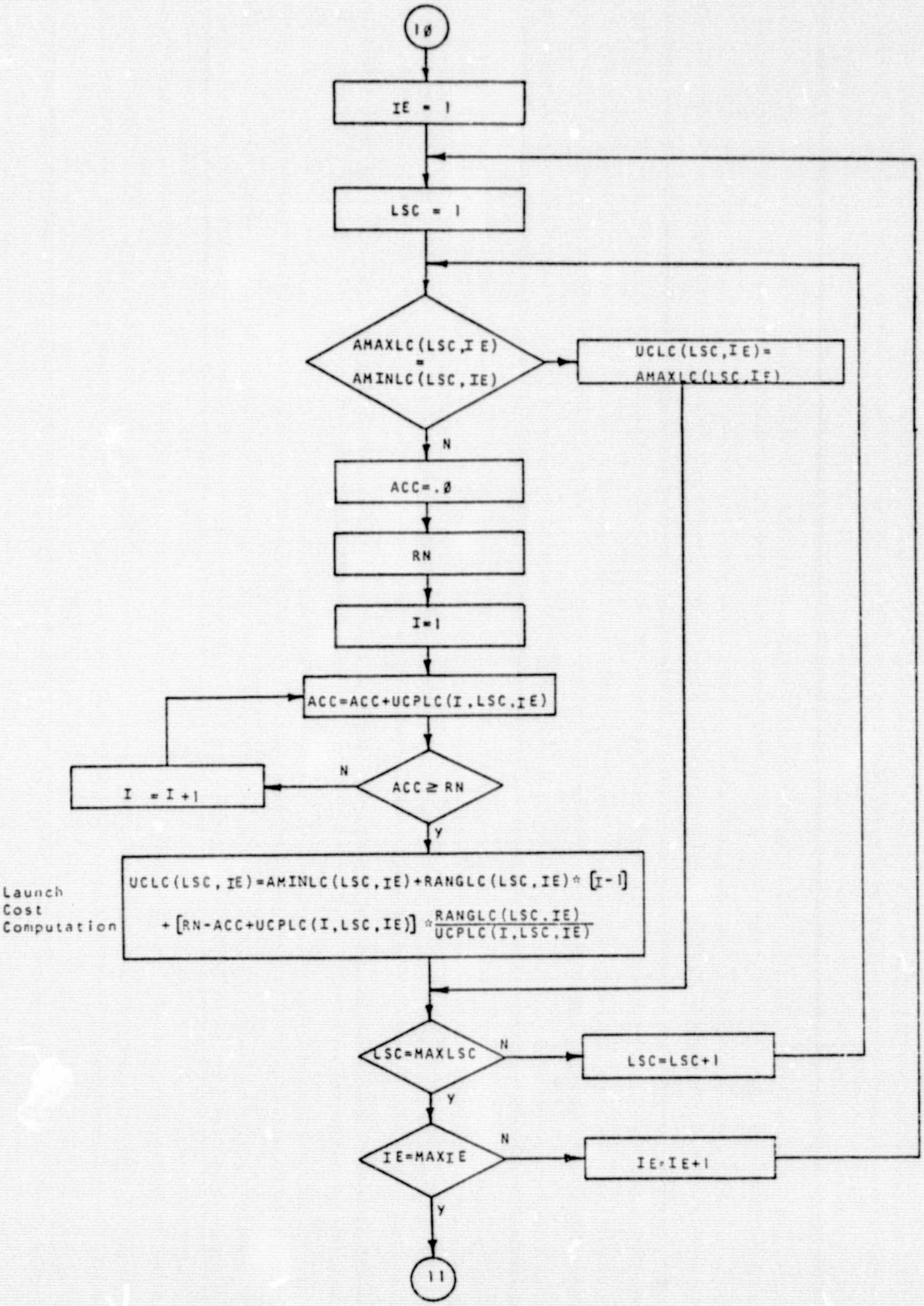

9A
AMAXM = AMINM
Y
N
UCM=AMAXM
ACC=.ϕ
RN
I = 1
ACC=ACC+UCPM(I)
ACC ≥ RN
N
I = I+1
Y
UCM=AMINM+RANGEM* [I-1]
+[RN-ACC+UCPM(I)] * RANGEM / UCPM(I)
1Ø
S/C refurbishment
and maintenance
cost computation

C-2

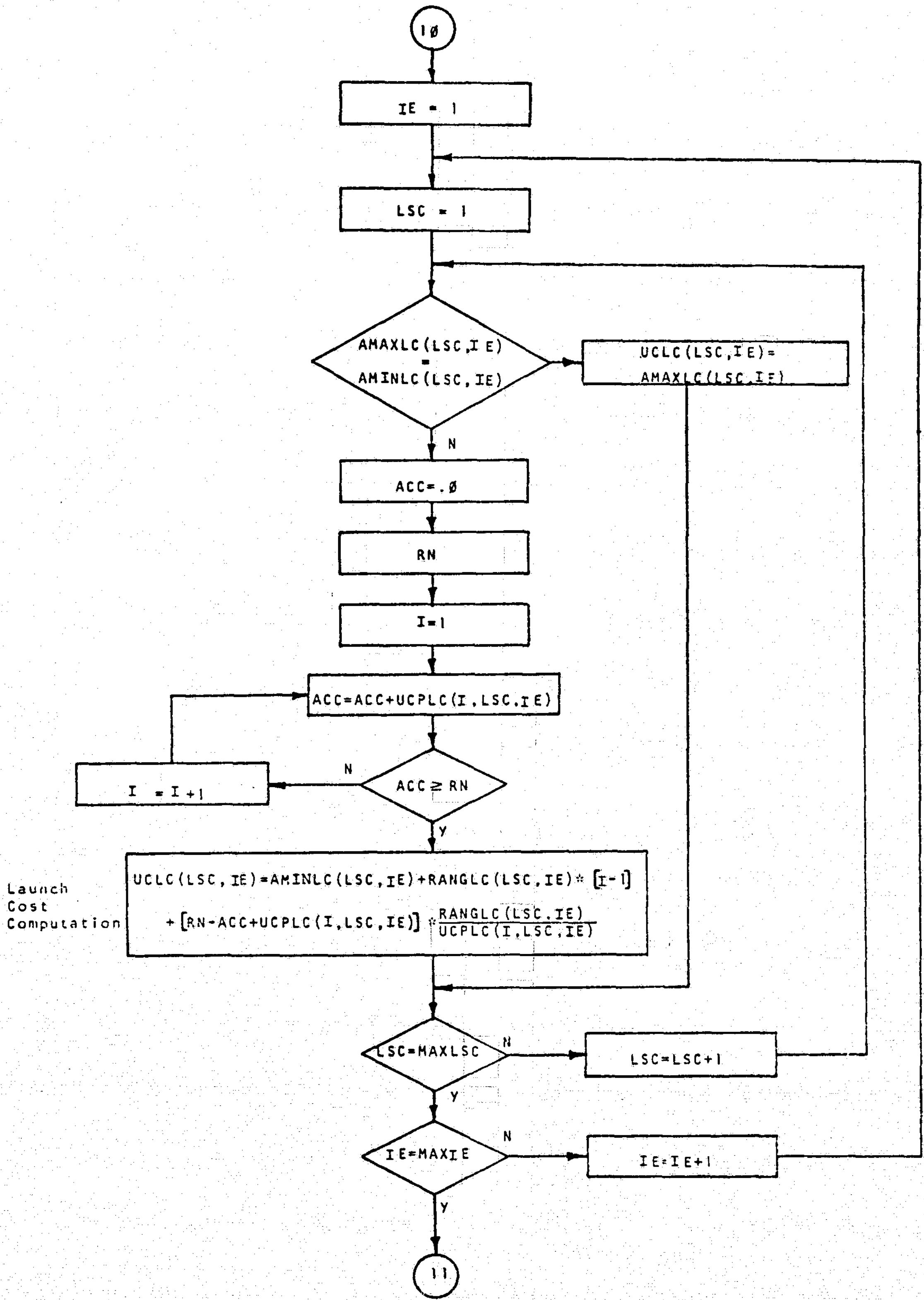


9A
AMAXM = AMINM
Y
N
UCM=AMAXM
ACC=.ϕ
RN
I = 1
ACC=ACC+UCPM(I)
ACC ≥ RN
N
I = I+1
y
UCM=AMINM+RANGEM* [I-1]
+[RN-ACC+UCPM(I)]*RANGEM/UCPM(I)
1Ø
S/C refurbishment and maintenance cost computation

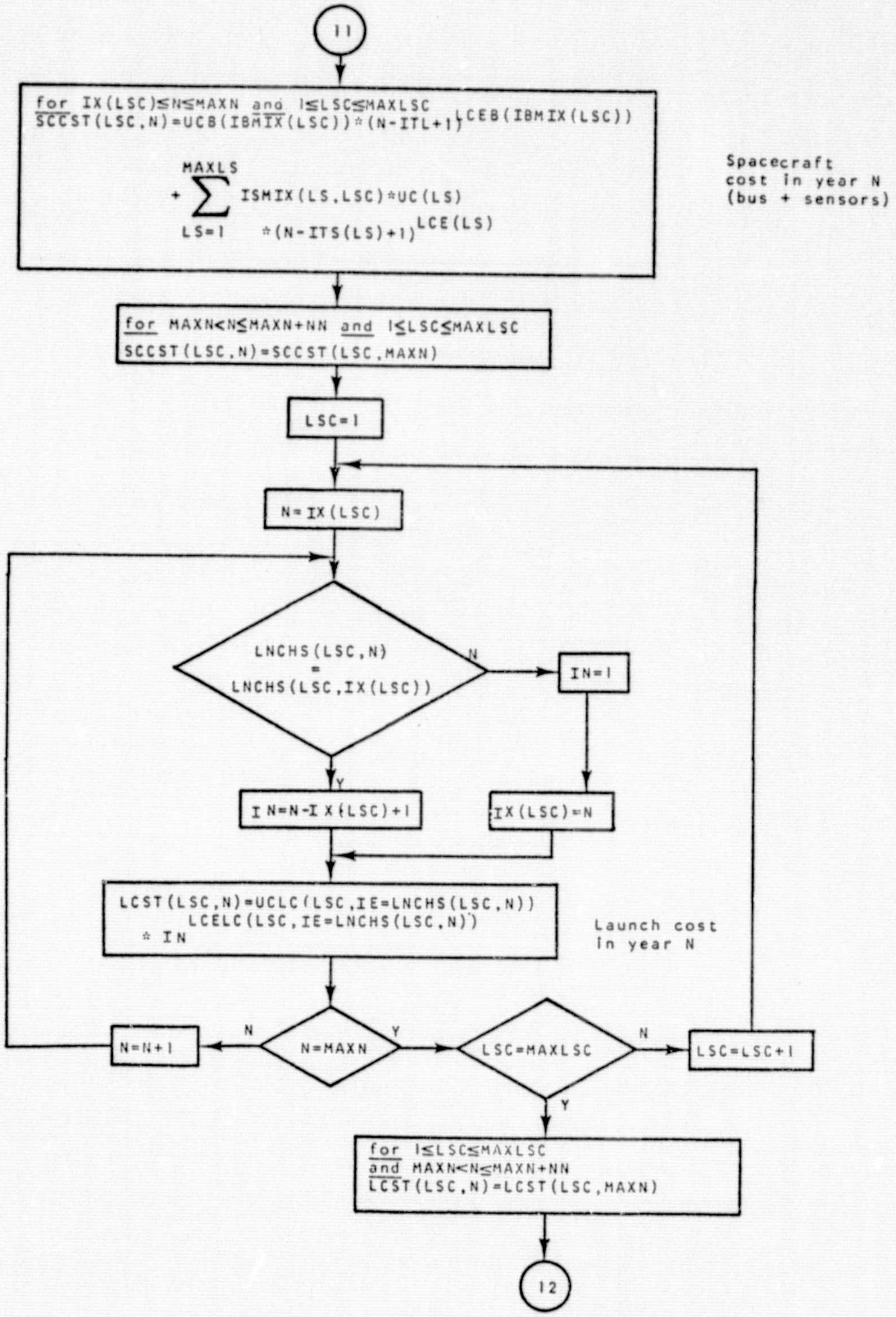
C-2

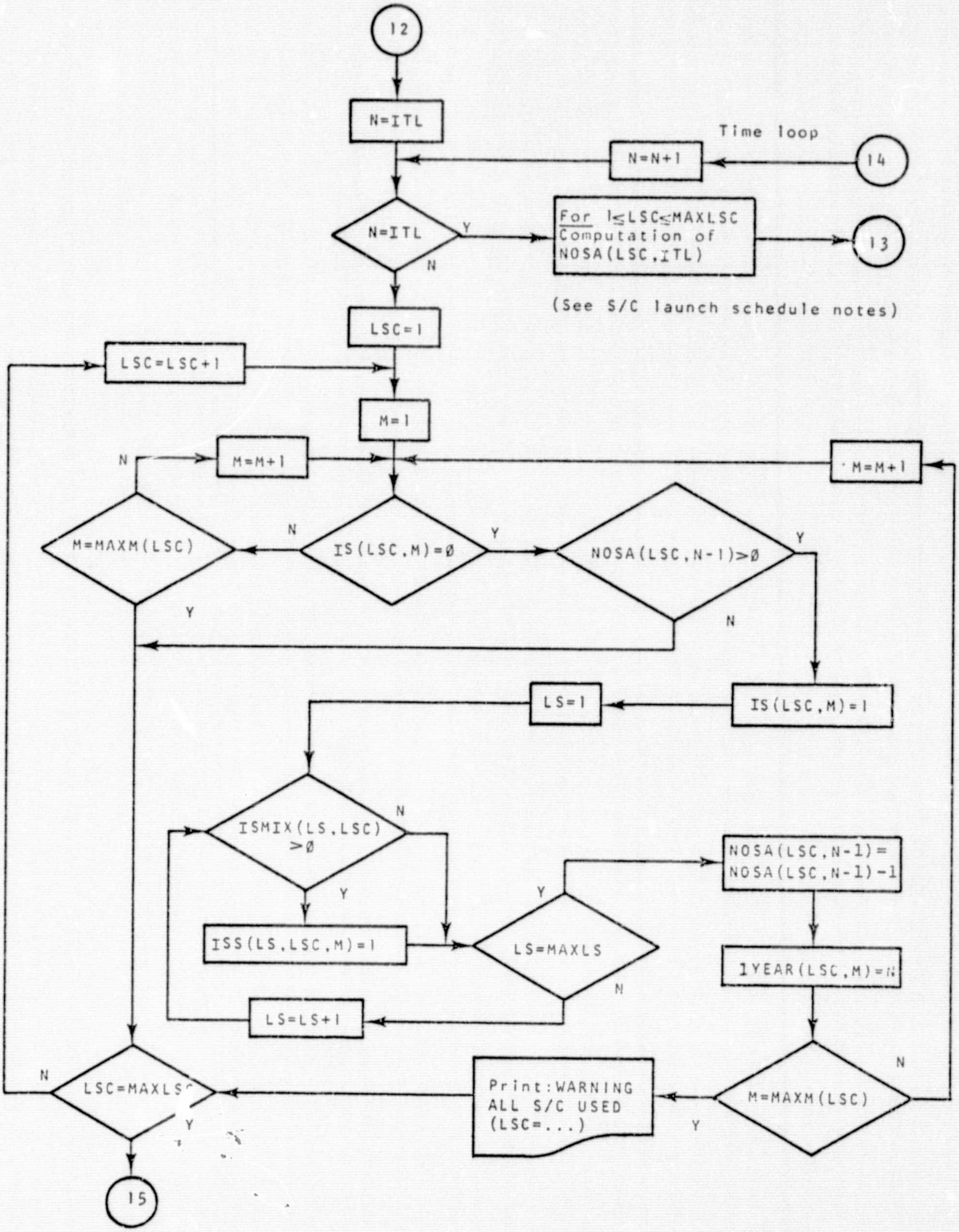


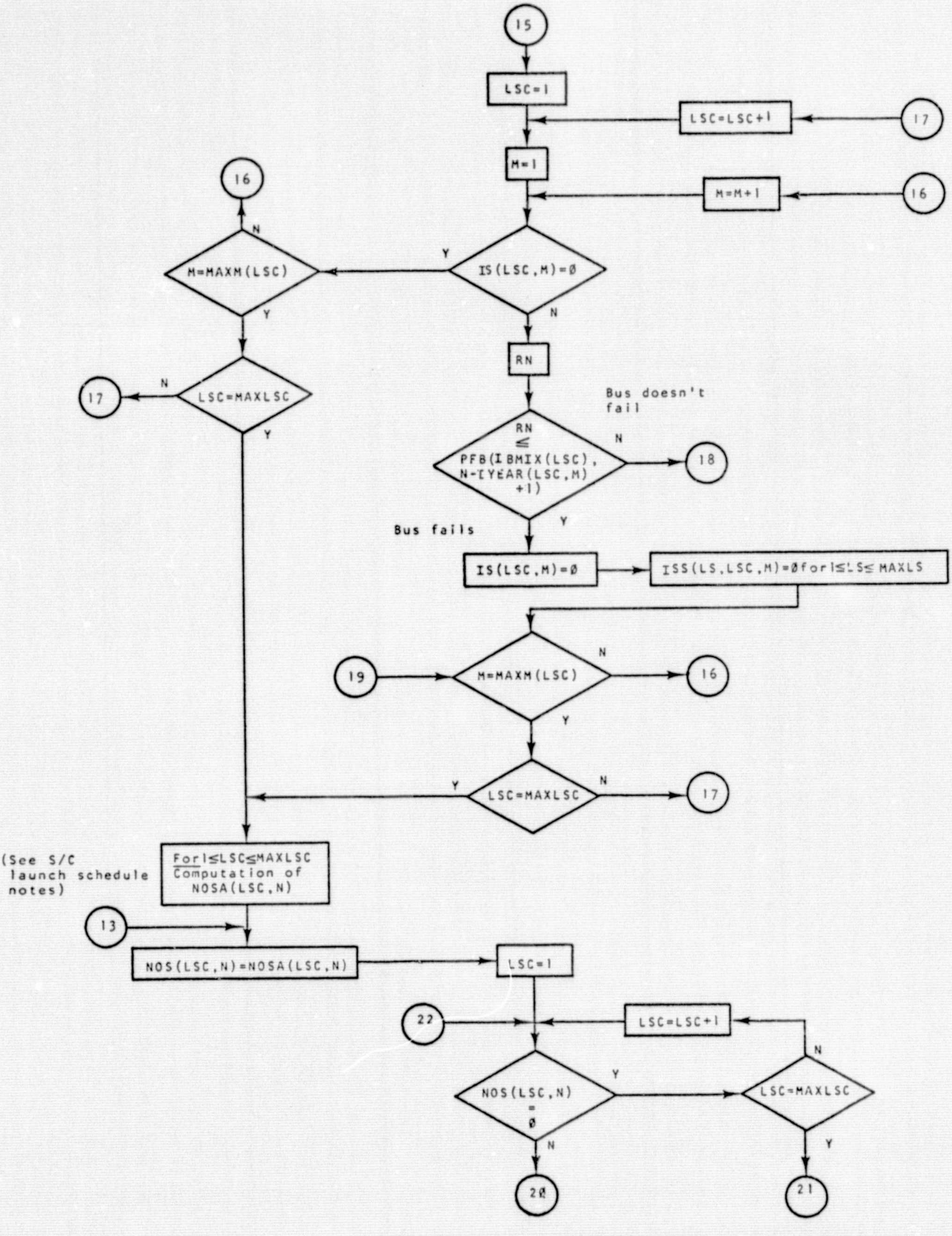
1Ø
IE = 1
LSC = 1
AMAXLC(LSC,IE) = AMINLC(LSC,IE)
UCLC(LSC,IE)= AMAXLC(LSC,IE)
N
ACC=.Ø
RN
I=1
ACC=ACC+UCPLC(I,LSC,IE)
N
ACC ≥ RN
I = I + 1
Y
Launch Cost Computation
UCLC(LSC,IE)=AMINLC(LSC,IE)+RANGLC(LSC,IE)* [I-1] + [RN-ACC+UCPLC(I,LSC,IE)] * RANGLC(LSC,IE) / UCPLC(I,LSC,IE)
LSC=MAXLSC
N
LSC=LSC+1
Y
IE=MAXIE
N
IE=IE+1
Y
11



10
IE = 1
LSC = 1
AMAXLC(LSC,IE) = AMINLC(LSC,IE)
UCLC(LSC,IE)= AMAXLC(LSC,IE)
N
ACC=.0
RN
I=1
ACC=ACC+UCPLC(I,LSC,IE)
N
ACC ≥ RN
I = I+1
Y
Launch Cost Computation
UCLC(LSC,IE)=AMINLC(LSC,IE)+RANGLC(LSC,IE)* [I-1] + [RN-ACC+UCPLC(I,LSC,IE)] * RANGLC(LSC,IE) / UCPLC(I,LSC,IE)
LSC=MAXLSC
N
LSC=LSC+1
Y
IE=MAXIE
N
IE=IE+1
Y
11


11
for IX(LSC)≤N≤MAXN and 1≤LSC≤MAXLSC
SCCST(LSC,N)=UCB(IBMIX(LSC))*(N-ITL+1)^LCEB(IBMIX(LSC))
+ Σ (LS=1 to MAXLS) ISMIX(LS,LSC)*UC(LS) *(N-ITS(LS)+1)^LCE(LS)
Spacecraft cost in year N (bus + sensors)
for MAXN<N≤MAXN+NN and 1≤LSC≤MAXLSC
SCCST(LSC,N)=SCCST(LSC,MAXN)
LSC=1
N=IX(LSC)
LNCHS(LSC,N) = LNCHS(LSC,IX(LSC))
N
IN=1
Y
IN=N-IX(LSC)+1
IX(LSC)=N
LCST(LSC,N)=UCLC(LSC,IE=LNCHS(LSC,N)) LCELC(LSC,IE=LNCHS(LSC,N)) * IN
Launch cost in year N
N=N+1
N
N=MAXN
Y
LSC=MAXLSC
N
LSC=LSC+1
Y
for 1≤LSC≤MAXLSC
and MAXN<N≤MAXN+NN
LCST(LSC,N)=LCST(LSC,MAXN)
12


12
N=ITL
Time loop
N=N+1
14
N=ITL
Y
N
For 1≤LSC≤MAXLSC
Computation of
NOSA(LSC,ITL)
13
(See S/C launch schedule notes)
LSC=1
LSC=LSC+1
M=1
N
M=M+1
M=M+1
M=MAXM(LSC)
N
IS(LSC,M)=Ø
Y
NOSA(LSC,N-1)>Ø
Y
Y
N
LS=1
IS(LSC,M)=1
ISMIX(LS,LSC)
>Ø
N
Y
NOSA(LSC,N-1)=
NOSA(LSC,N-1)-1
Y
ISS(LS,LSC,M)=1
LS=MAXLS
1YEAR(LSC,M)=N
N
LS=LS+1
N
LSC=MAXLSC
Print:WARNING
ALL S/C USED
(LSC=...)
M=MAXM(LSC)
N
Y
Y
15



15
LSC=1
LSC=LSC+1
17
M=1
M=M+1
16
16
N
M=MAXM(LSC)
Y
IS(LSC,M)=Ø
N
Y
RN
17
N
LSC=MAXLSC
Y
Bus doesn't fail
RN ≤ PFB(IBMIX(LSC), N-IYEAR(LSC,M) +1)
N
18
Y
Bus fails
IS(LSC,M)=Ø
ISS(LS,LSC,M)=Øfor1≤LS≤MAXLS
19
M=MAXM(LSC)
N
16
Y
Y
LSC=MAXLSC
N
17
(See S/C launch schedule notes)
For1≤LSC≤MAXLSC Computation of NOSA(LSC,N)
13
NOS(LSC,N)=NOSA(LSC,N)
LSC=1
22
LSC=LSC+1
N
NOS(LSC,N) = Ø
Y
LSC=MAXLSC
N
Y
2Ø
21

Notes on Determination of S/C Launch Schedule (NOSA(LSC,N))

$$\text{Minimize}\left\{\sum_{I=N}^{N+NN}\left\{PVF(I)*\sum_{LSC=1}^{MAXLSC}(SCCST(LSC,I)+LCST(LSC,I))*NOSA(LSC,I)\right\}\right\}$$

Subject to:

$$NOOP(LS,N)+\sum_{LSC=1}^{MAXLSC}\left\{ISMIX(LS,LSC)*\sum_{=N}^{N+NN}NOSA(LSC,I)\right\}\geq NOSEN(LS,I)$$

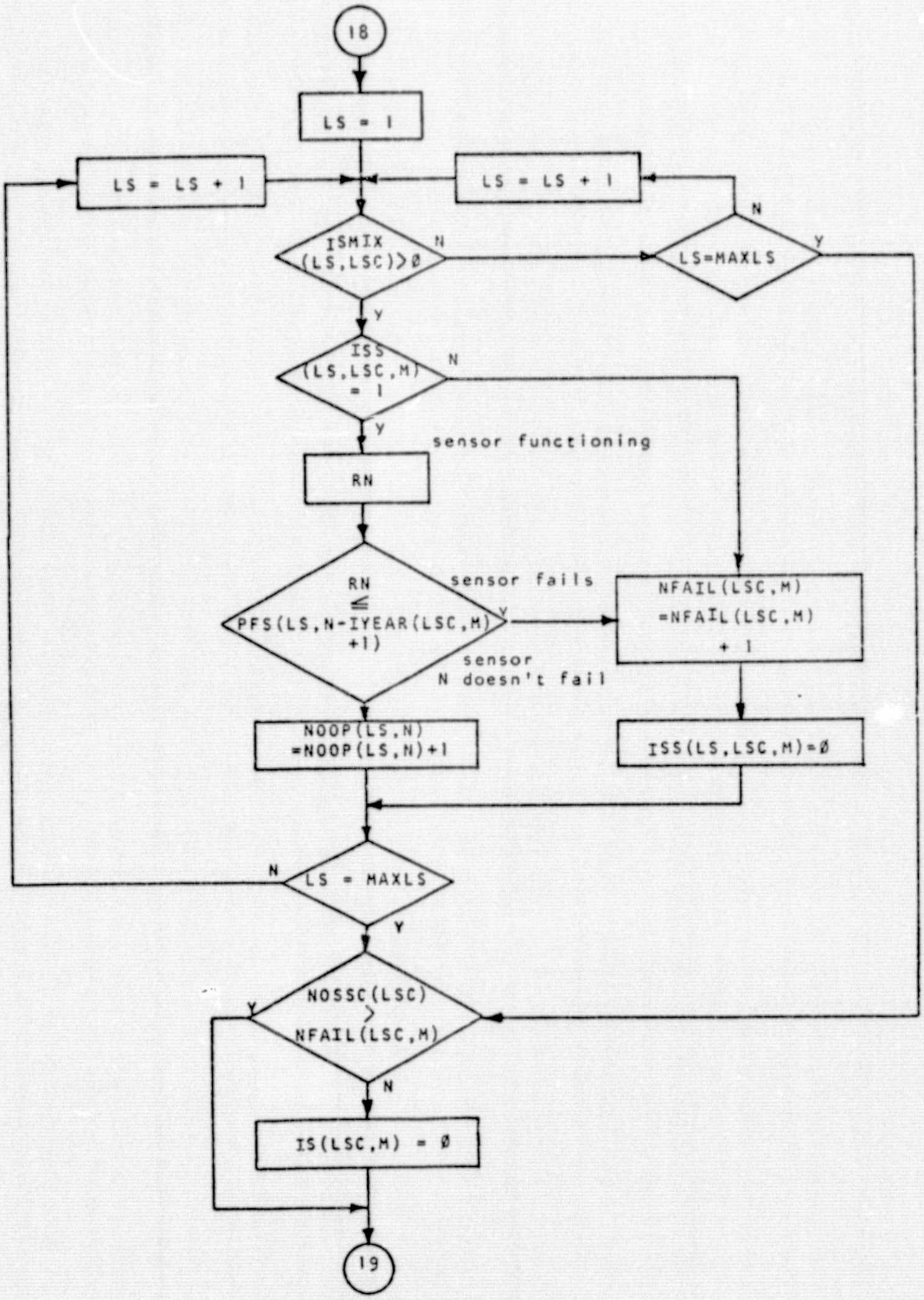
for each I such that $N\leq I\leq N+NN$
and for $1\leq LS\leq MAXLS$

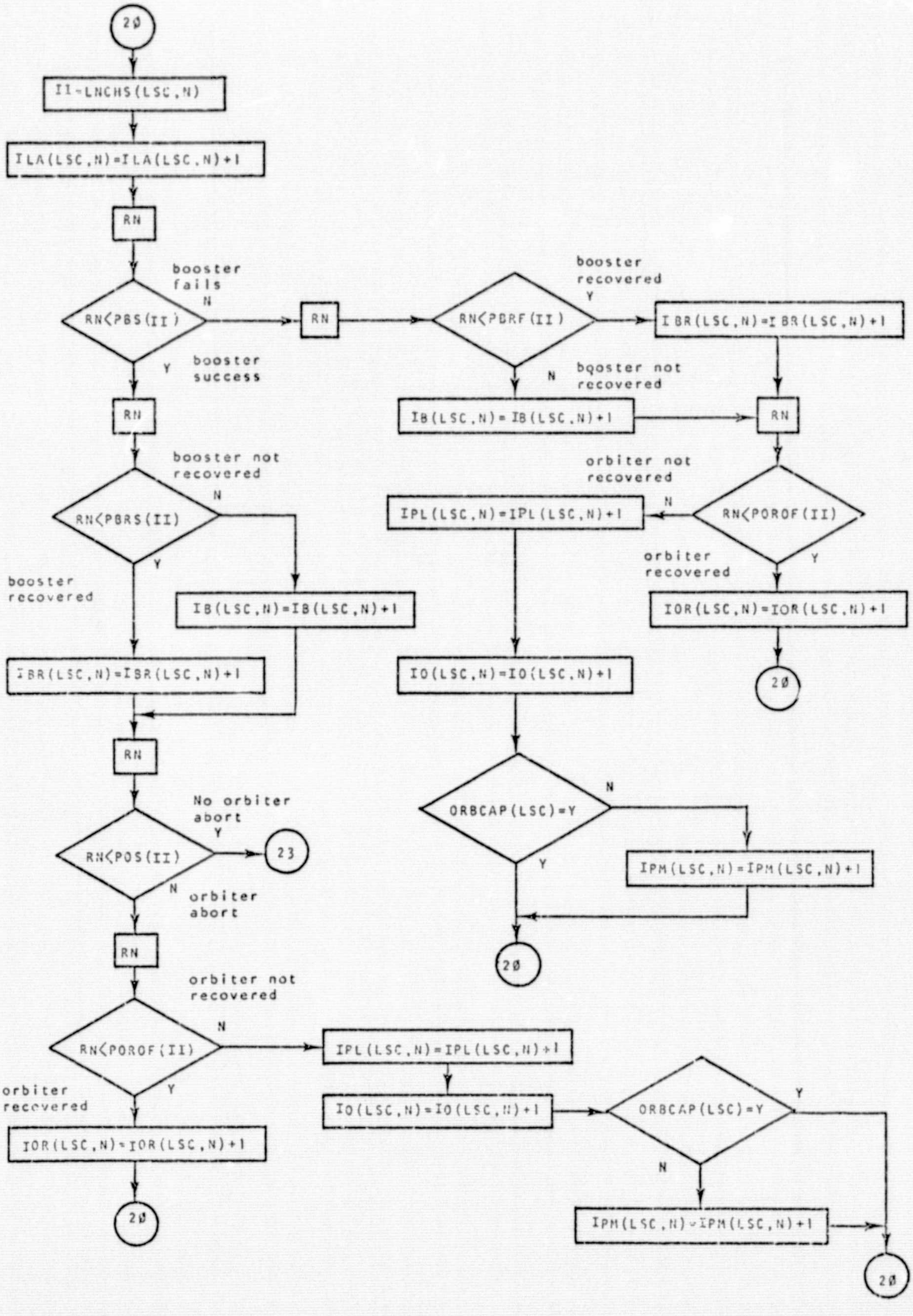
Inputs

N	start of the time horizon (years)
NN	number of time periods (years) to be considered
PVF(I)	present value factor
MAXLSC	maximum number of S/C types
SCCST(LSC,I)	cost of the LSC S/C in year I
LCST(LSC,I)	cost of the launch of the LSC S/C in year I
NOOP(LS,N)	number of sensors of type LS operating successfully at the end of year N
ISMIX(LS,LSC)	sensor types available on the LSC spacecraft (Ø or 1)
NOSEN(LS,I)	number of sensors of type LS required in operation in year I.

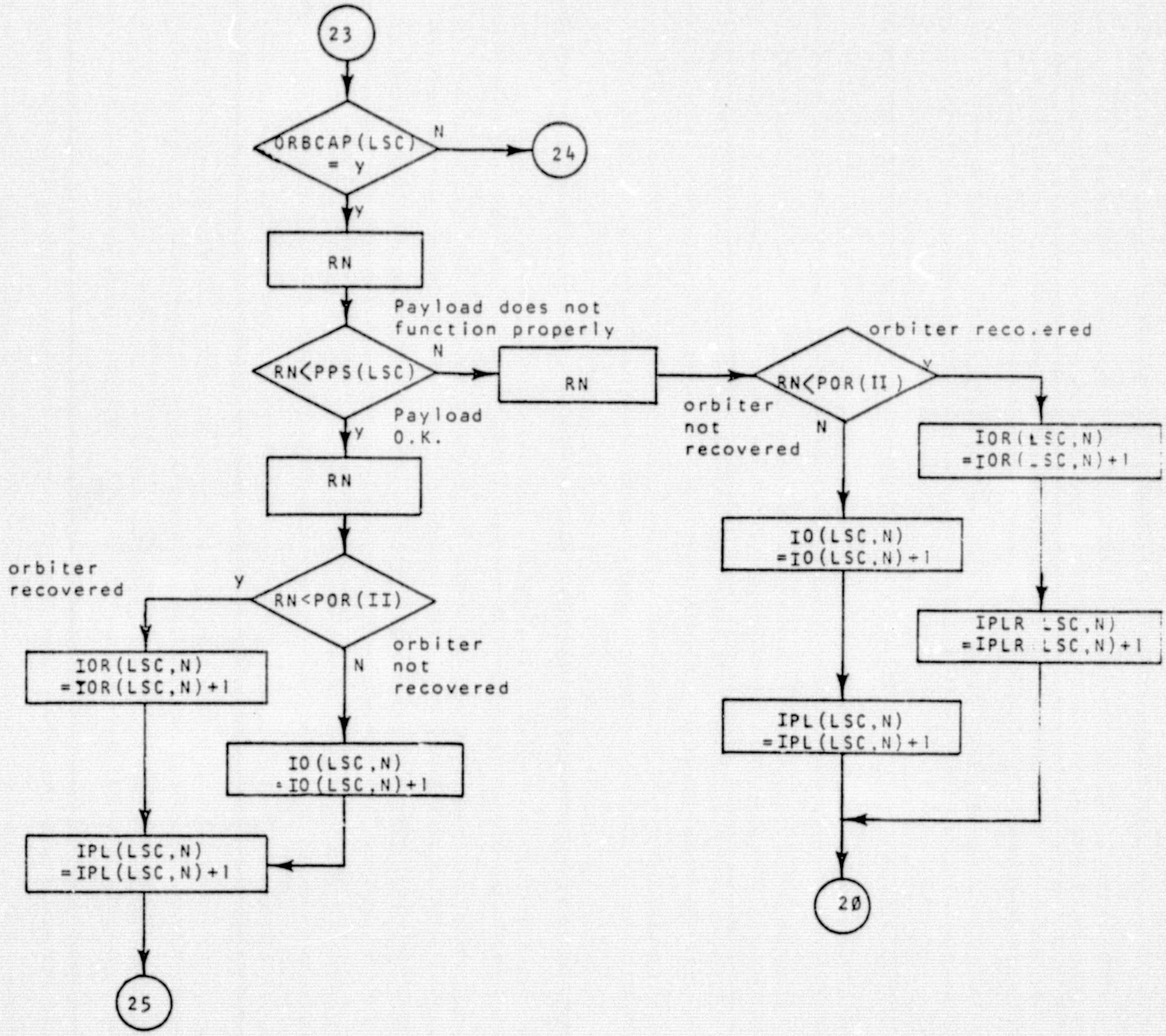
Output

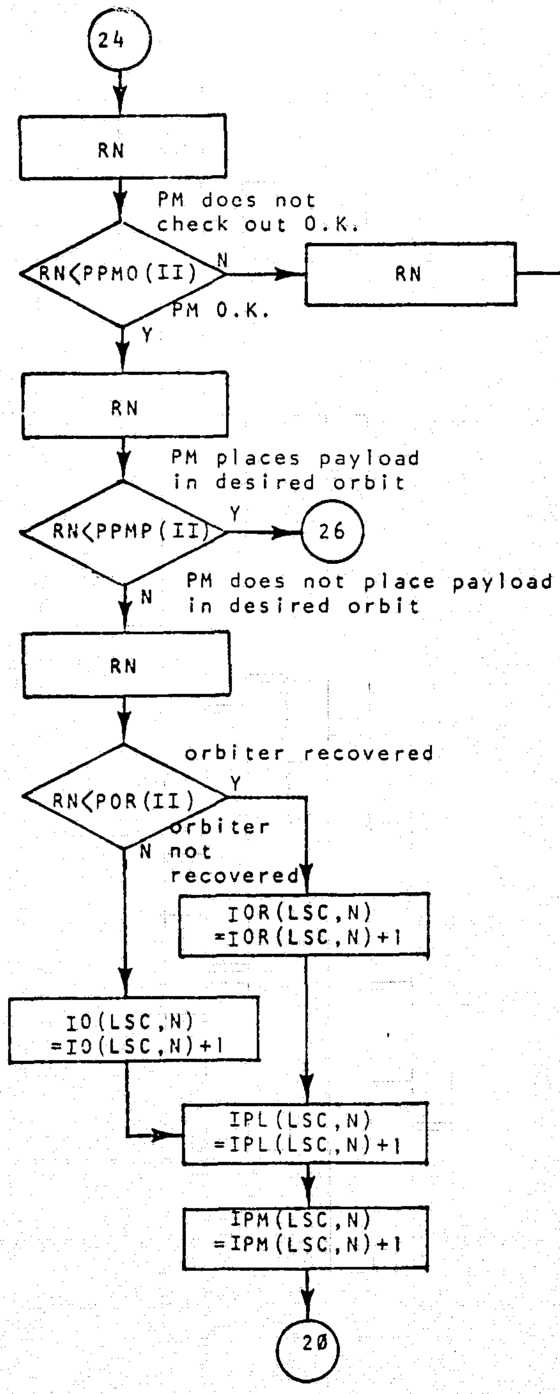
NOSA(LSC,I)	number of S/C of type LSC to be placed successfully in orbit in year I.


18
LS = 1
LS = LS + 1
LS = LS + 1
ISMIX (LS,LSC)>Ø
N
Y
LS=MAXLS
N
Y
ISS (LS,LSC,M) = 1
N
Y
sensor functioning
RN
RN ≦ PFS(LS,N-IYEAR(LSC,M) +1)
sensor fails
Y
sensor
N doesn't fail
NFAIL(LSC,M) =NFAIL(LSC,M) + 1
NOOP(LS,N) =NOOP(LS,N)+1
ISS(LS,LSC,M)=Ø
N
LS = MAXLS
Y
NOSSC(LSC) > NFAIL(LSC,M)
Y
N
IS(LSC,M) = Ø
19

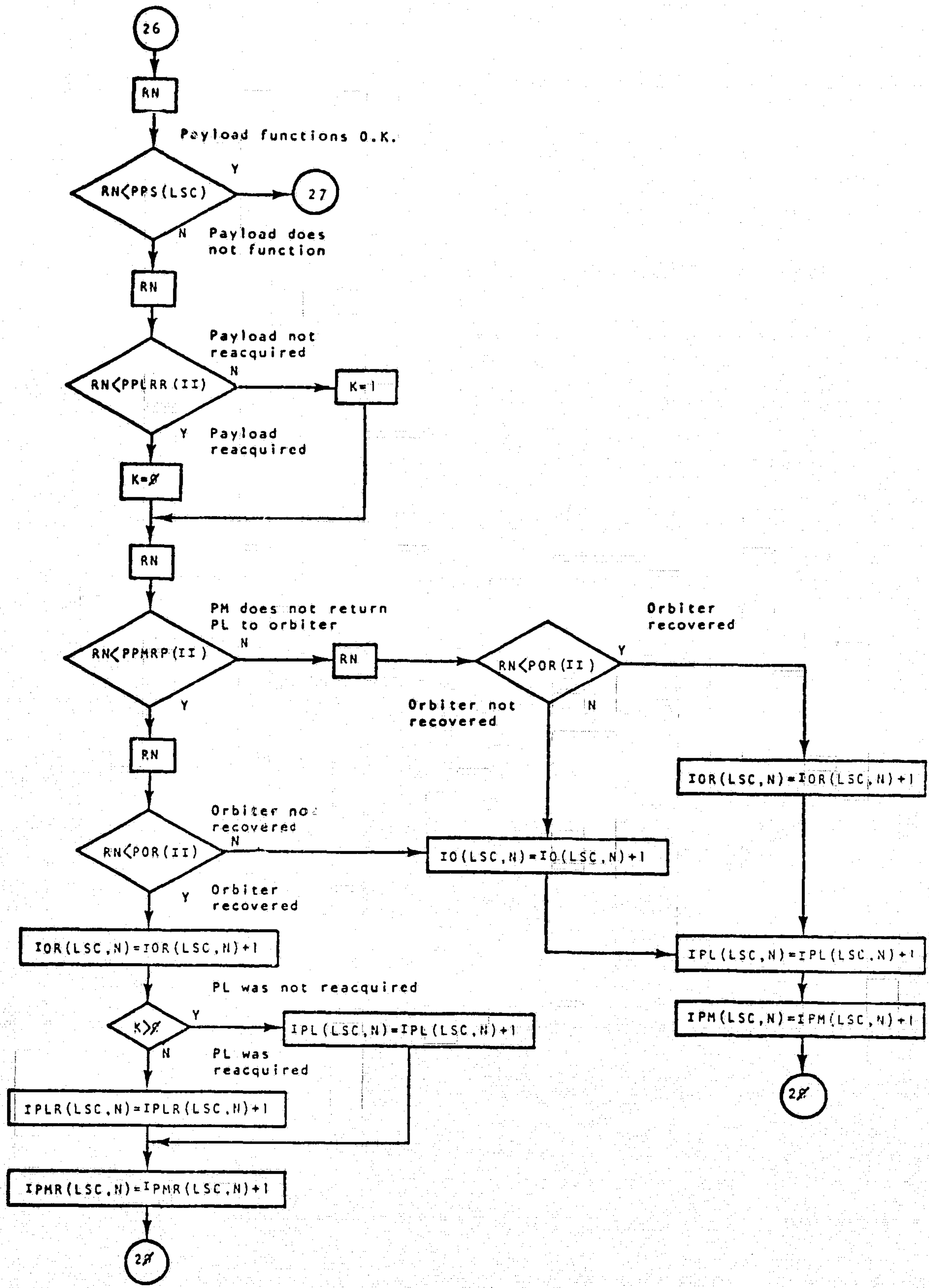


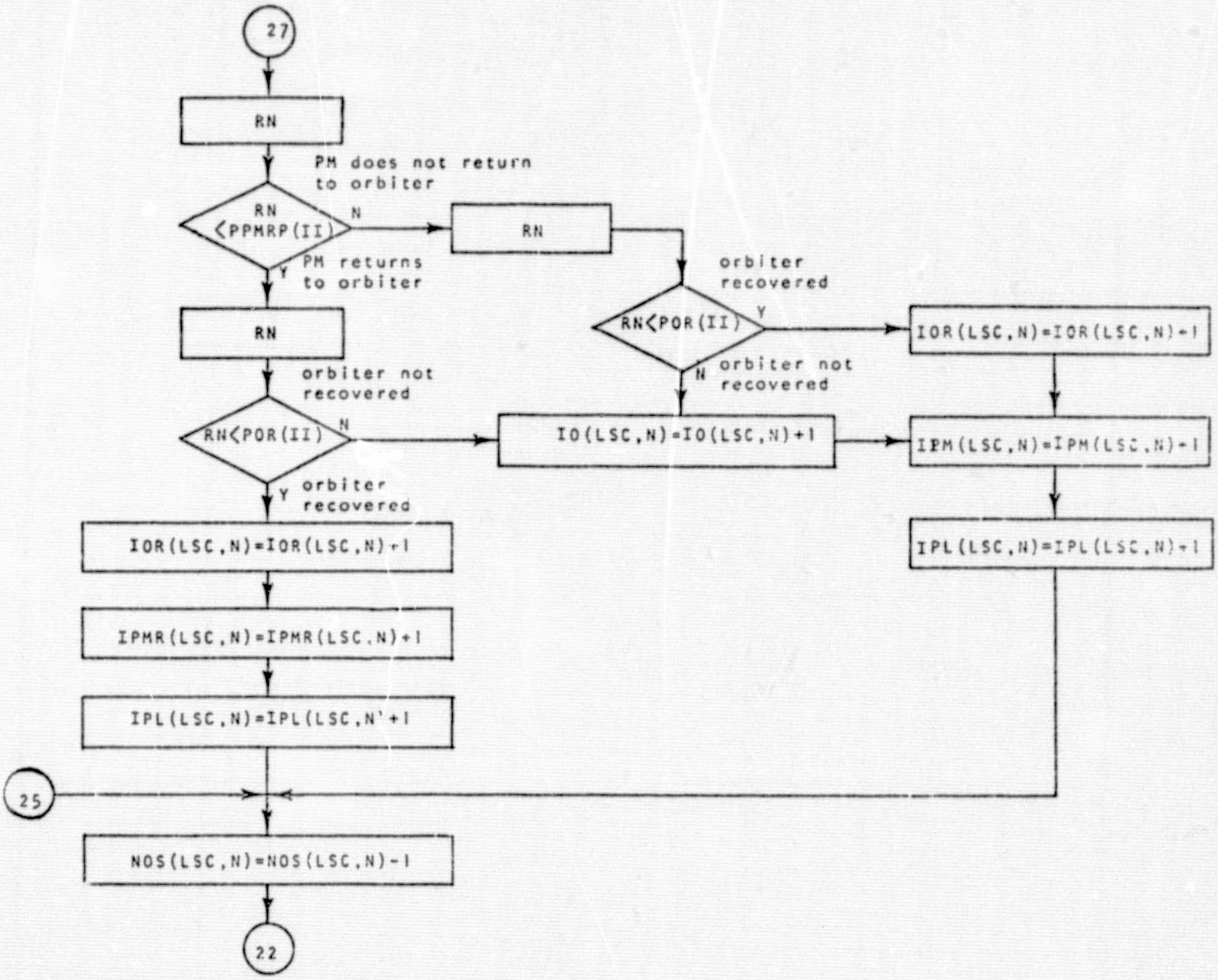
20
II=LNCHS(LSC,N)
ILA(LSC,N)=ILA(LSC,N)+1
RN
booster fails
N
RN<PBS(II)
Y
booster success
RN
RN<PBRF(II)
booster recovered
Y
IBR(LSC,N)=IBR(LSC,N)+1
N
booster not recovered
IB(LSC,N)=IB(LSC,N)+1
RN
orbiter not recovered
N
IPL(LSC,N)=IPL(LSC,N)+1
RN<POROF(II)
orbiter recovered
Y
IOR(LSC,N)=IOR(LSC,N)+1
20
RN
booster not recovered
N
RN<PBRS(II)
Y
booster recovered
IB(LSC,N)=IB(LSC,N)+1
IBR(LSC,N)=IBR(LSC,N)+1
IO(LSC,N)=IO(LSC,N)+1
RN
No orbiter abort
Y
RN<POS(II)
23
N
orbiter abort
ORBCAP(LSC)=Y
N
Y
IPM(LSC,N)=IPM(LSC,N)+1
20
RN
orbiter not recovered
N
RN<POROF(II)
IPL(LSC,N)=IPL(LSC,N)+1
Y
orbiter recovered
IO(LSC,N)=IO(LSC,N)+1
ORBCAP(LSC)=Y
Y
N
IOR(LSC,N)=IOR(LSC,N)+1
IPM(LSC,N)=IPM(LSC,N)+1
20
20

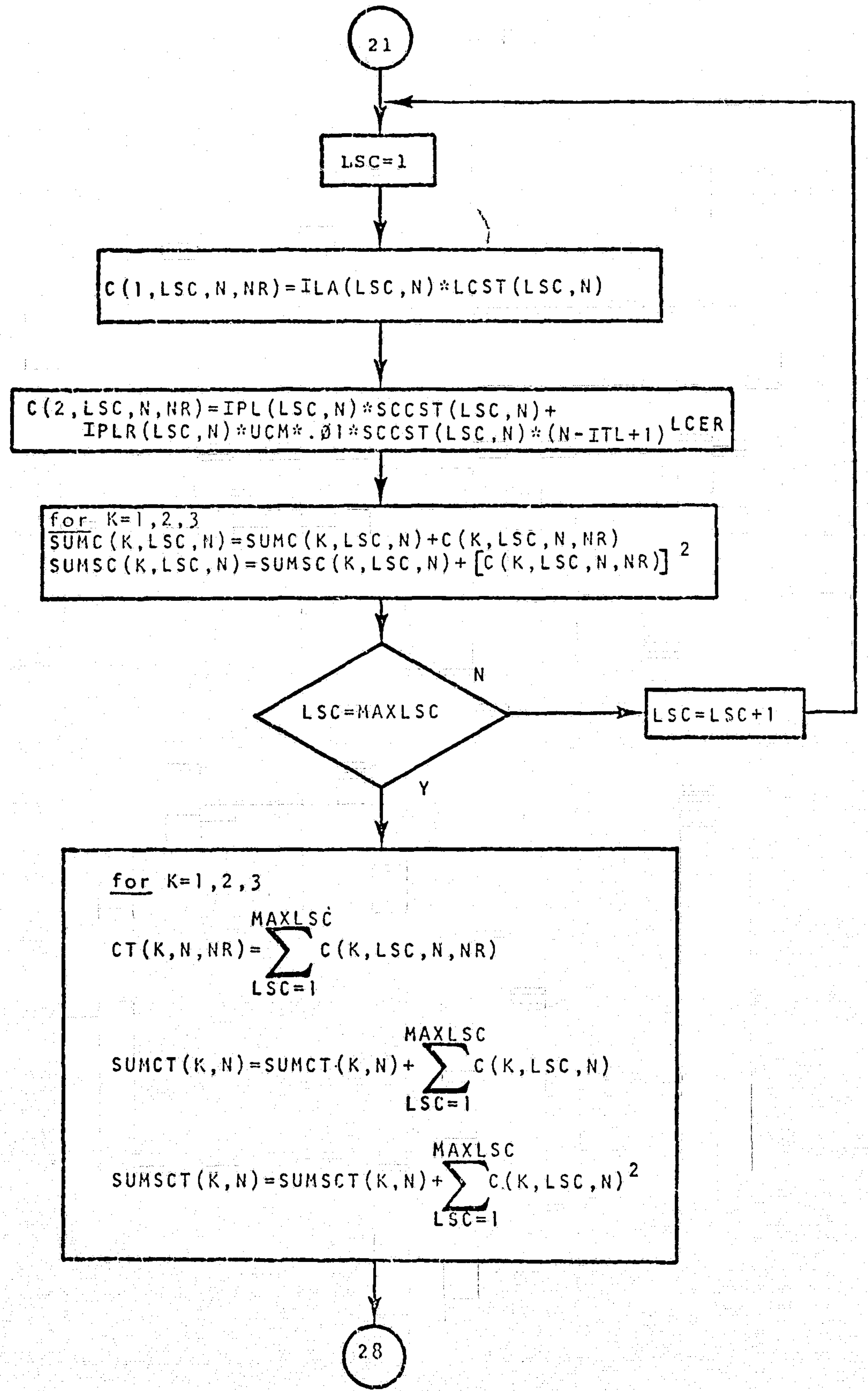

23
ORBCAP(LSC) = y
N
24
y
RN
Payload does not function properly
N
RN<PPS(LSC)
RN
orbiter reco.ered
y
RN<POR(II)
Payload O.K.
y
orbiter not recovered
N
IOR(LSC,N) =IOR(LSC,N)+1
RN
IO(LSC,N) =IO(LSC,N)+1
orbiter recovered
y
RN<POR(II)
IPLR(LSC,N) =IPLR(LSC,N)+1
orbiter not recovered
N
IOR(LSC,N) =IOR(LSC,N)+1
IPL(LSC,N) =IPL(LSC,N)+1
IO(LSC,N) =IO(LSC,N)+1
IPL(LSC,N) =IPL(LSC,N)+1
20
25



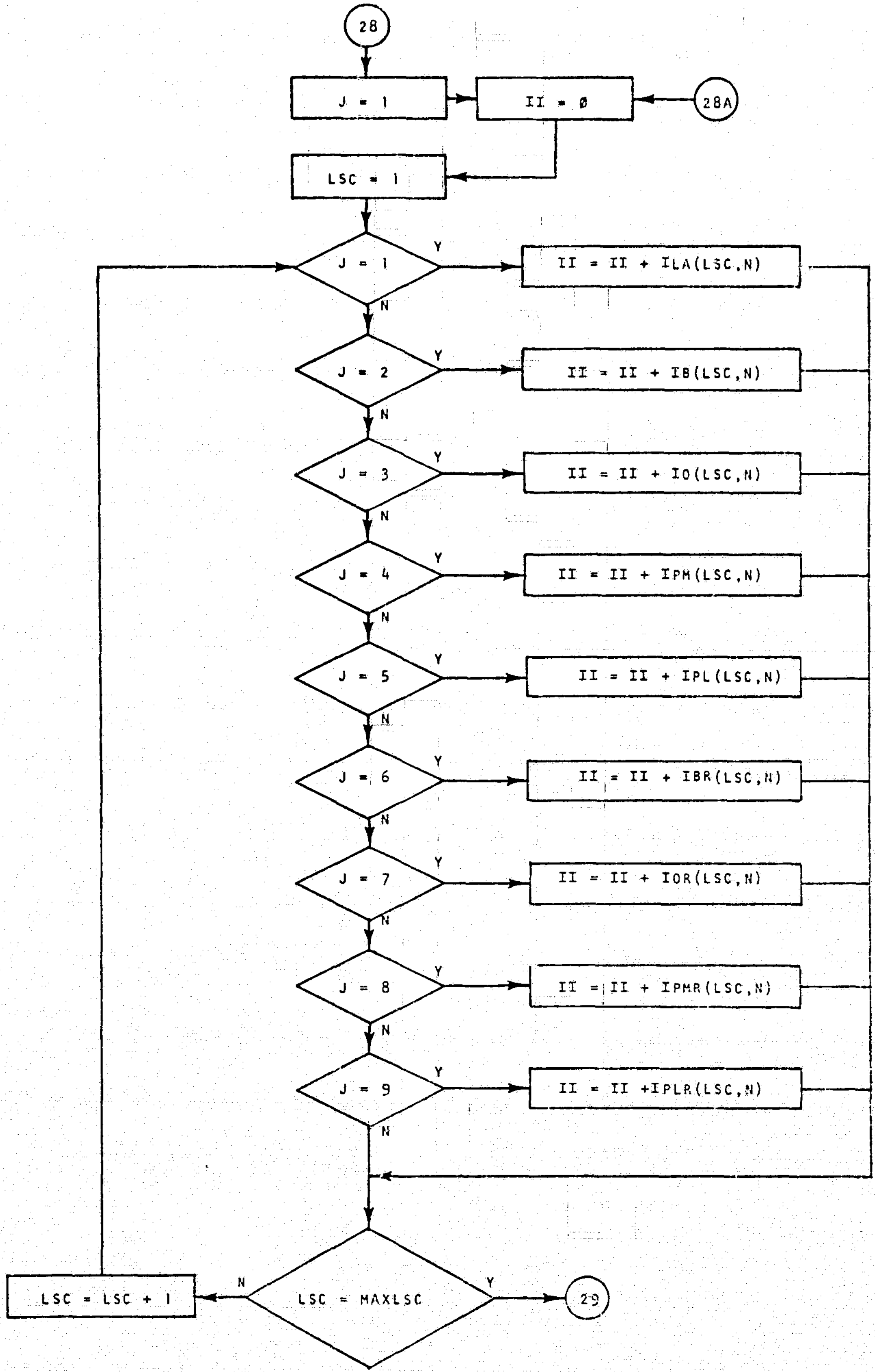
24
RN
PM does not check out O.K.
RN<PPMO(II)
N
Y
PM O.K.
RN
RN<POR(II)
orbiter recovered
orbiter not recovered
IO(LSC,N) =IO(LSC,N)+1
IOR(LSC,N) =IOR(LSC,N)+1
IPL(LSC,N) =IPL(LSC,N)+1
IPMR(LSC,N) =IPMR(LSC,N)+1
IPM(LSC,N) =IPM(LSC,N)+1
20
RN
PM places payload in desired orbit
RN<PPMP(II)
26
PM does not place payload in desired orbit
RN
orbiter recovered
RN<POR(II)
orbiter not recovered
IOR(LSC,N) =IOR(LSC,N)+1
IO(LSC,N) =IO(LSC,N)+1
IPL(LSC,N) =IPL(LSC,N)+1
IPM(LSC,N) =IPM(LSC,N)+1
20

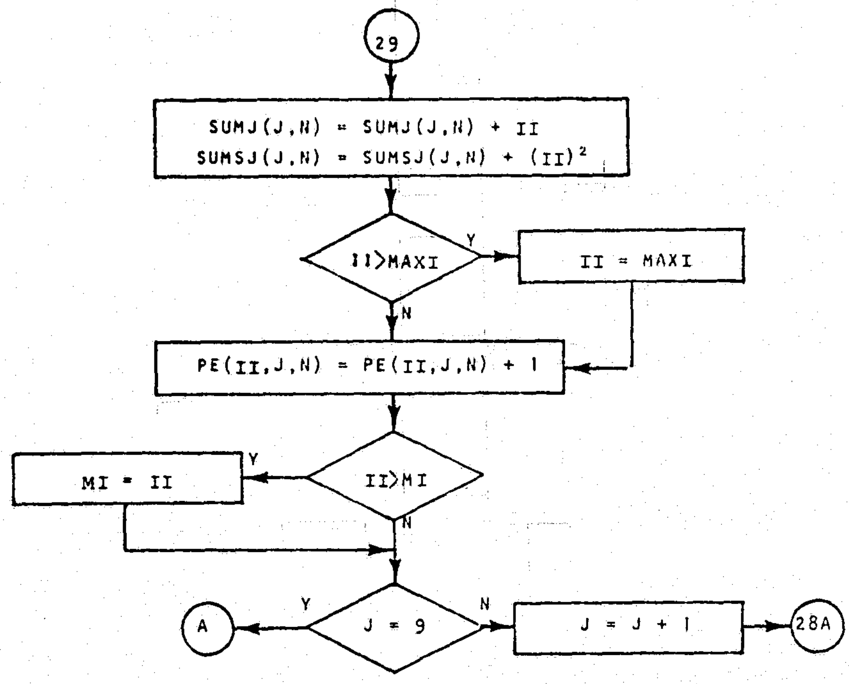

26
RN
Payload functions O.K.
RN<PPS(LSC)
Y
27
N
Payload does not function
RN
Payload not reacquired
N
RN<PPLRR(II)
K=1
Y
Payload reacquired
K=Ø
RN
PM does not return PL to orbiter
N
RN<PPMRP(II)
RN
RN<POR(II)
Orbiter recovered
Y
Orbiter not recovered
N
IOR(LSC,N)=IOR(LSC,N)+1
Y
RN
Orbiter not recovered
N
RN<POR(II)
IO(LSC,N)=IO(LSC,N)+1
Y
Orbiter recovered
IOR(LSC,N)=IOR(LSC,N)+1
IPL(LSC,N)=IPL(LSC,N)+1
PL was not reacquired
IPM(LSC,N)=IPM(LSC,N)+1
K>Ø
Y
IPL(LSC,N)=IPL(LSC,N)+1
N
PL was reacquired
2Ø
IPLR(LSC,N)=IPLR(LSC,N)+1
IPMR(LSC,N)=IPMR(LSC,N)+1
2Ø

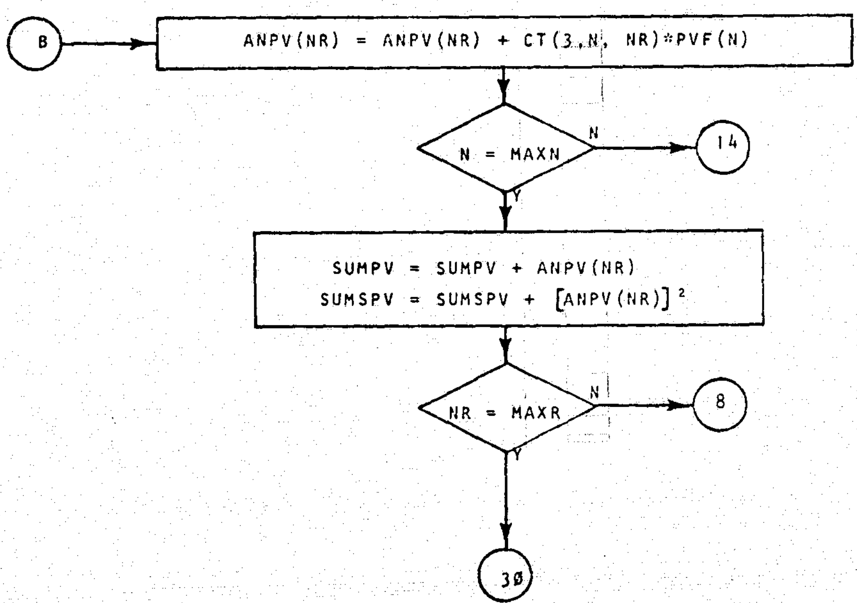

27
RN
PM does not return to orbiter
RN <PPMRP(II)
N
Y
RN
PM returns to orbiter
RN
orbiter recovered
RN<POR(II)
Y
N
orbiter not recovered
IOR(LSC,N)=IOR(LSC,N)+1
orbiter not recovered
RN<POR(II)
N
Y
orbiter recovered
IO(LSC,N)=IO(LSC,N)+1
IPM(LSC,N)=IPM(LSC,N)+1
IPL(LSC,N)=IPL(LSC,N)+1
IOR(LSC,N)=IOR(LSC,N)+1
IPMR(LSC,N)=IPMR(LSC,N)+1
IPL(LSC,N)=IPL(LSC,N'+1
25
NOS(LSC,N)=NOS(LSC,N)-1
22

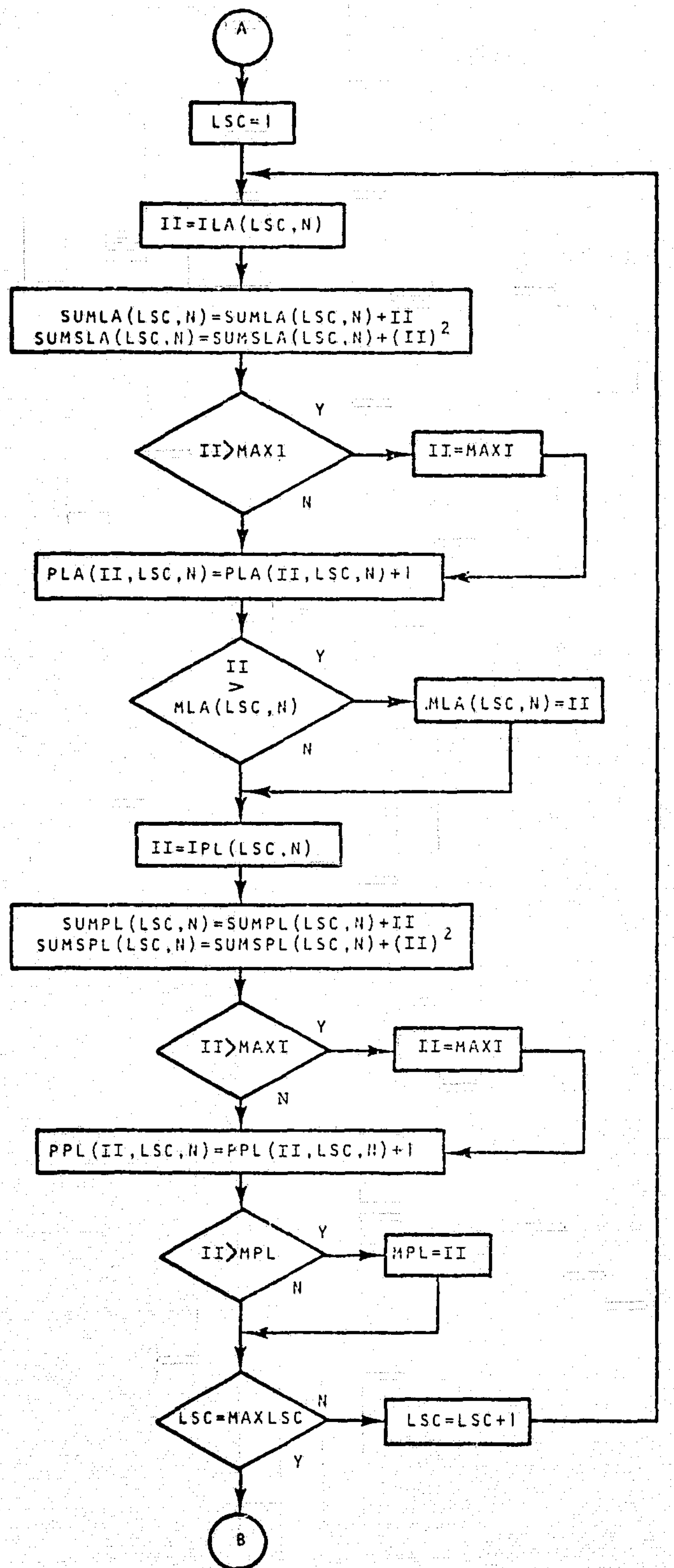


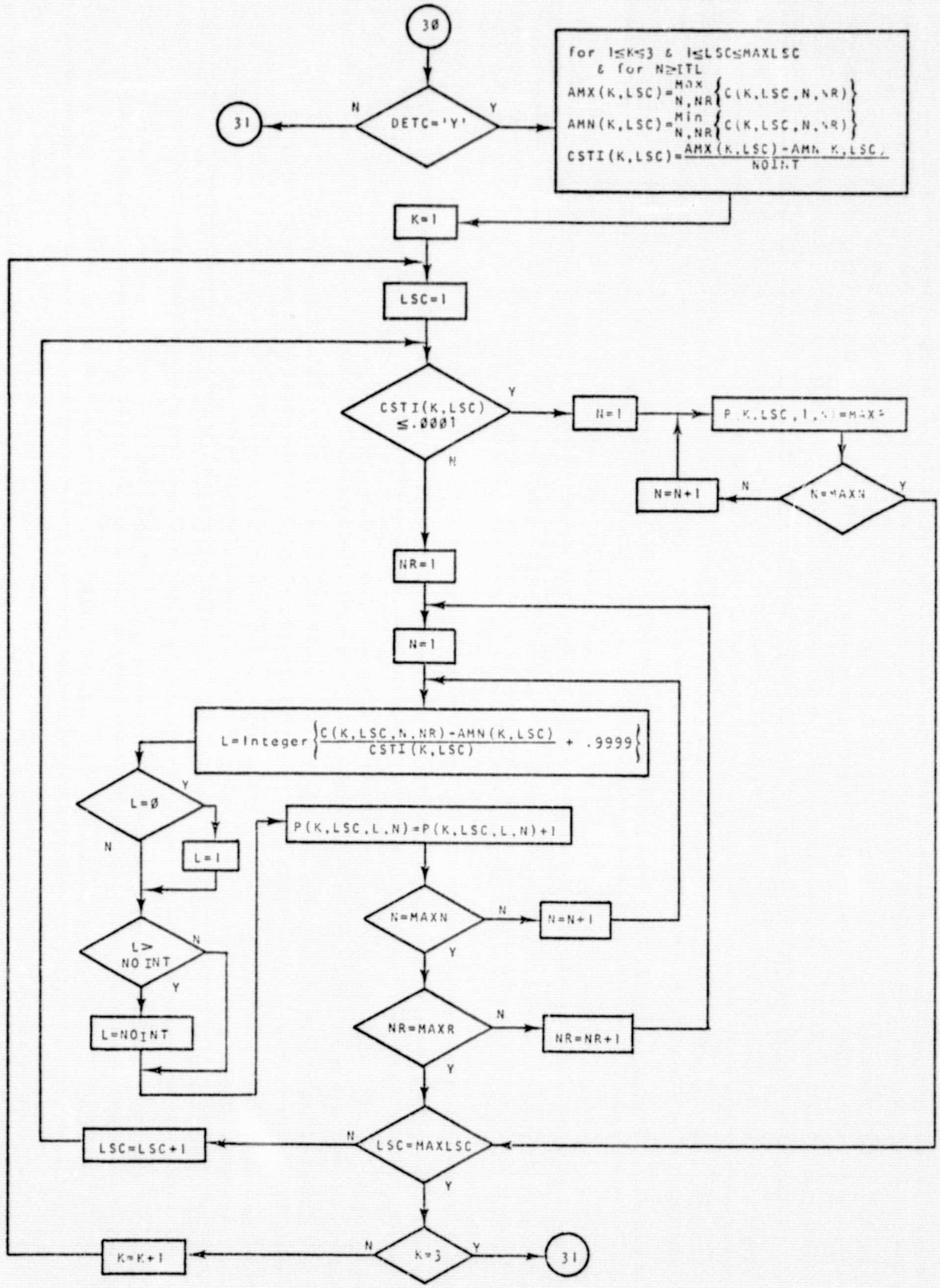
21
LSC=1
C(1,LSC,N,NR)=ILA(LSC,N)*LCST(LSC,N)
C(2,LSC,N,NR)=IPL(LSC,N)*SCCST(LSC,N)+
IPLR(LSC,N)*UCM*.Ø1*SCCST(LSC,N)*(N-ITL+1)^LCER
for K=1,2,3
SUMC(K,LSC,N)=SUMC(K,LSC,N)+C(K,LSC,N,NR)
SUMSC(K,LSC,N)=SUMSC(K,LSC,N)+[C(K,LSC,N,NR)]^2
LSC=MAXLSC
N
LSC=LSC+1
Y
for K=1,2,3
CT(K,N,NR)= Σ_{LSC=1}^{MAXLSC} C(K,LSC,N,NR)
SUMCT(K,N)=SUMCT(K,N)+ Σ_{LSC=1}^{MAXLSC} C(K,LSC,N)
SUMSCT(K,N)=SUMSCT(K,N)+ Σ_{LSC=1}^{MAXLSC} C(K,LSC,N)^2
28


28
J = 1
II = Ø
28A
LSC = 1
J = 1
II = II + ILA(LSC,N)
J = 2
II = II + IB(LSC,N)
J = 3
II = II + IO(LSC,N)
J = 4
II = II + IPM(LSC,N)
J = 5
II = II + IPL(LSC,N)
J = 6
II = II + IBR(LSC,N)
J = 7
II = II + IOR(LSC,N)
J = 8
II = II + IPMR(LSC,N)
J = 9
II = II +IPLR(LSC,N)
LSC = LSC + 1
LSC = MAXLSC
29

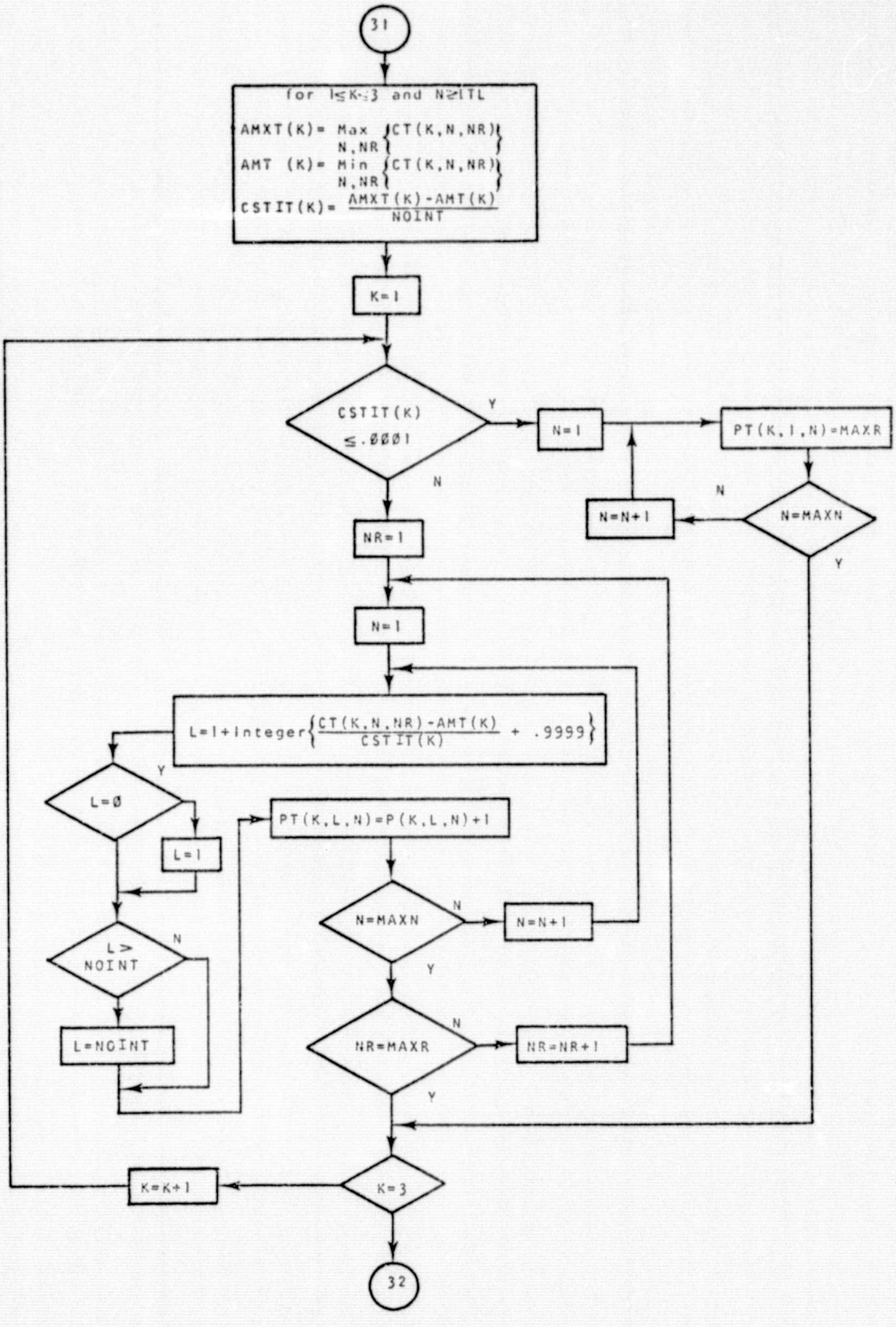

29
SUMJ(J,N) = SUMJ(J,N) + II
SUMSJ(J,N) = SUMSJ(J,N) + (II)²
II>MAXI
Y
N
II = MAXI
PE(II,J,N) = PE(II,J,N) + 1
II>MI
Y
N
MI = II
J = 9
Y
N
A
J = J + 1
28A

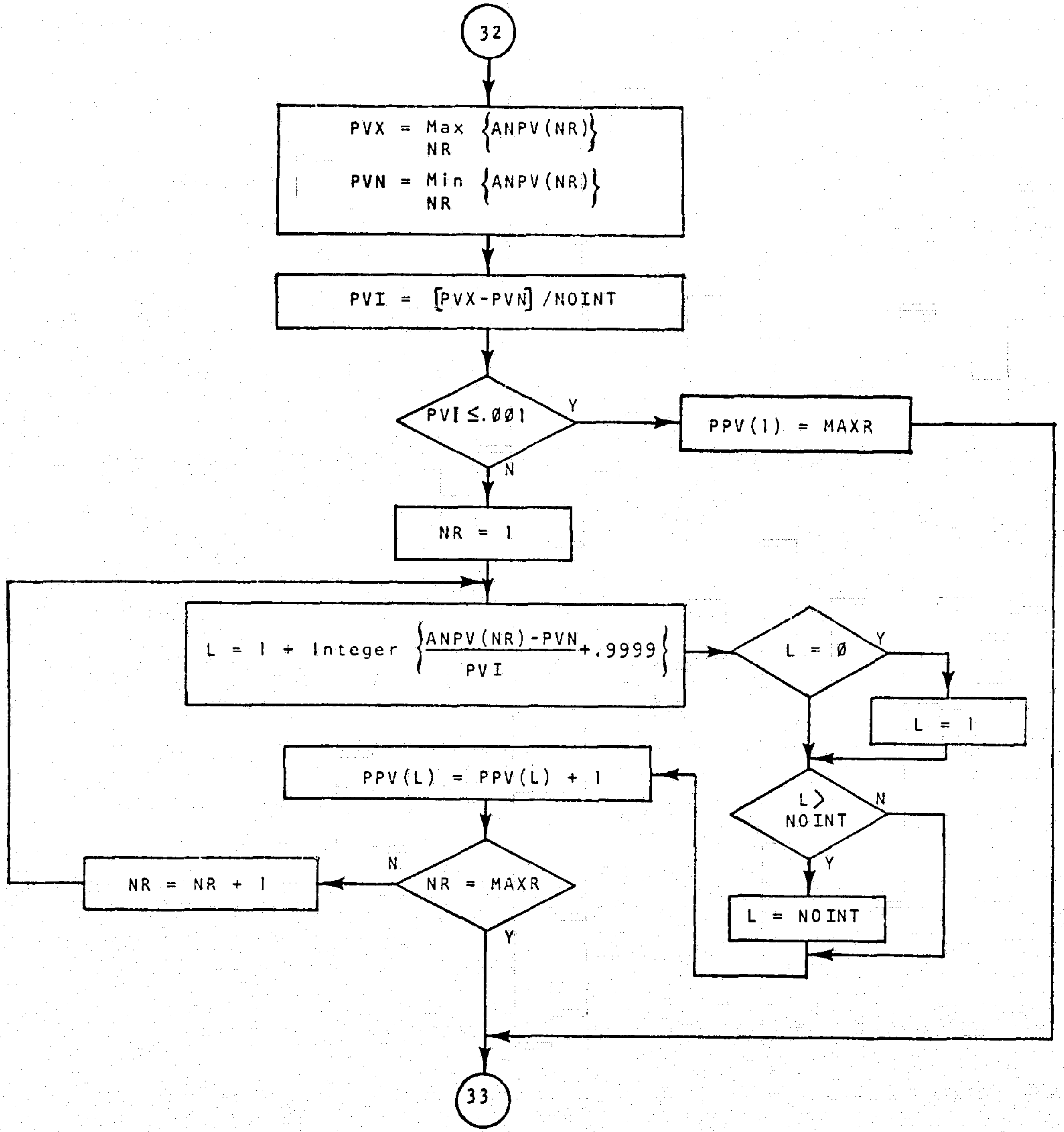

B
ANPV(NR) = ANPV(NR) + CT(3,N, NR)*PVF(N)
N = MAXN
N
Y
14
SUMPV = SUMPV + ANPV(NR)
SUMSPV = SUMSPV + [ANPV(NR)]²
NR = MAXR
N
Y
8
30


A
LSC=1
II=ILA(LSC,N)
SUMLA(LSC,N)=SUMLA(LSC,N)+II
SUMSLA(LSC,N)=SUMSLA(LSC,N)+(II)^2
II>MAXI
Y
N
II=MAXI
PLA(II,LSC,N)=PLA(II,LSC,N)+1
II > MLA(LSC,N)
Y
N
MLA(LSC,N)=II
II=IPL(LSC,N)
SUMPL(LSC,N)=SUMPL(LSC,N)+II
SUMSPL(LSC,N)=SUMSPL(LSC,N)+(II)^2
II>MAXI
Y
N
II=MAXI
PPL(II,LSC,N)=PPL(II,LSC,N)+1
II>MPL
Y
N
MPL=II
LSC=MAXLSC
N
Y
LSC=LSC+1
B

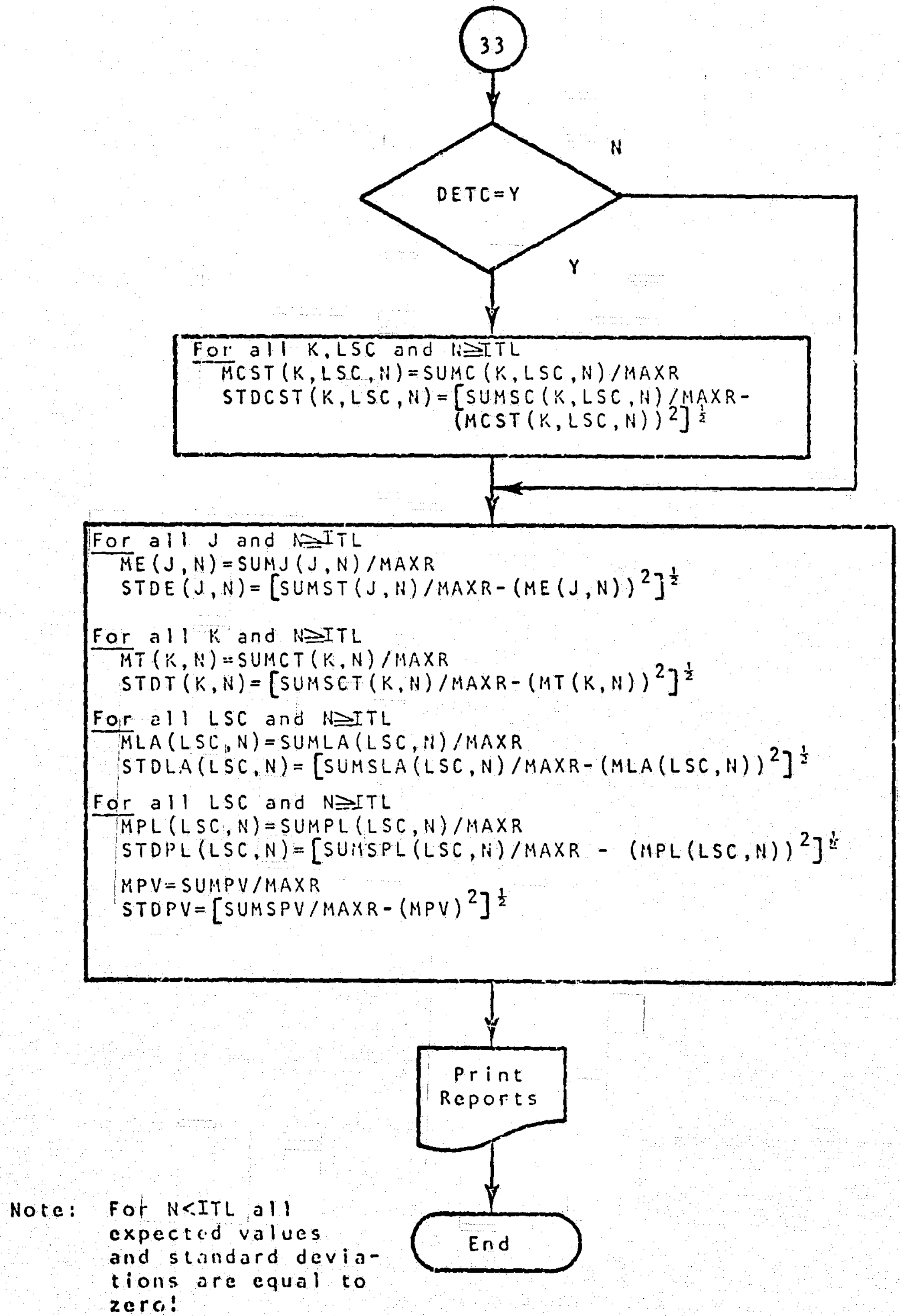


30
DETC='Y'
N
Y
31
for 1≤K≤3 & 1≤LSC≤MAXLSC
& for N≥ITL
AMX(K,LSC)=Max N,NR {C(K,LSC,N,NR)}
AMN(K,LSC)=Min N,NR {C(K,LSC,N,NR)}
CSTI(K,LSC)=AMX(K,LSC)-AMN(K,LSC) / NOINT
K=1
LSC=1
CSTI(K,LSC) ≤.0001
N=1
N=N+1
N=MAXN
NR=1
N=1
L=Integer {C(K,LSC,N,NR)-AMN(K,LSC) / CSTI(K,LSC) + .9999}
L=0
L=1
L> NOINT
L=NOINT
P(K,LSC,L,N)=P(K,LSC,L,N)+1
N=MAXN
N=N+1
NR=MAXR
NR=NR+1
LSC=MAXLSC
LSC=LSC+1
K=3
K=K+1
31


31
for 1≤K≤3 and N≥ITL
AMXT(K)= Max {CT(K,N,NR)}
N,NR
AMT (K)= Min {CT(K,N,NR)}
N,NR
CSTIT(K)= (AMXT(K)-AMT(K))/NOINT
K=1
CSTIT(K) ≤.ØØØ1
Y
N
N=1
PT(K,1,N)=MAXR
N=MAXN
N=N+1
NR=1
N=1
L=1+Integer{(CT(K,N,NR)-AMT(K))/CSTIT(K) + .9999}
L=Ø
L=1
L> NOINT
L=NOINT
PT(K,L,N)=P(K,L,N)+1
N=MAXN
N=N+1
NR=MAXR
NR=NR+1
K=3
K=K+1
32



32
PVX = Max NR {ANPV(NR)}
PVN = Min NR {ANPV(NR)}
PVI = [PVX-PVN] /NOINT
PVI ≤ .ØØ1
Y
N
PPV(1) = MAXR
NR = 1
L = 1 + Integer {ANPV(NR)-PVN / PVI + .9999}
L = Ø
Y
L = 1
PPV(L) = PPV(L) + 1
L > NOINT
N
Y
L = NOINT
NR = MAXR
N
Y
NR = NR + 1
33


33
DETC=Y
N
Y
For all K,LSC and N≥ITL
MCST(K,LSC,N)=SUMC(K,LSC,N)/MAXR
STDCST(K,LSC,N)=[SUMSC(K,LSC,N)/MAXR-(MCST(K,LSC,N))^2]^½
For all J and N≥ITL
ME(J,N)=SUMJ(J,N)/MAXR
STDE(J,N)=[SUMST(J,N)/MAXR-(ME(J,N))^2]^½
For all K and N≥ITL
MT(K,N)=SUMCT(K,N)/MAXR
STDT(K,N)=[SUMSCT(K,N)/MAXR-(MT(K,N))^2]^½
For all LSC and N≥ITL
MLA(LSC,N)=SUMLA(LSC,N)/MAXR
STDLA(LSC,N)=[SUMSLA(LSC,N)/MAXR-(MLA(LSC,N))^2]^½
For all LSC and N≥ITL
MPL(LSC,N)=SUMPL(LSC,N)/MAXR
STDPL(LSC,N)=[SUMSPL(LSC,N)/MAXR - (MPL(LSC,N))^2]^½
MPV=SUMPV/MAXR
STDPV=[SUMSPV/MAXR-(MPV)^2]^½
Print Reports
End
Note: For N<ITL all expected values and standard deviations are equal to zero!

4.6 Output Document Description

The following pages summarize the output documentation.

ESTABLISHMENT & MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED QUANTITY

YEAR: XX

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PM's REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PM's REFURB.	SPACECRAFT REFURB.
XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX
XXX	X.XXX	.	.	.	.	.	.	.	.
XXX	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX
XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX	X.XXX
EXPECTED NUMBER	XXX.XX	XXX.XX	XXX.XX	XXX.XX	XXX.XX	XXX.XX	XXX.XX	XXX.XX	XXX.XX
STD. DEV.	XXX.XX	XXX.XX	XXX.XX	XXX.XX	XXX.XX	XXX.XX	XXX.XX	XXX.XX	XXX.XX

ESTABLISHMENT & MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: N

PROBABILITY OF INDICATED QUANTITY

```
QUANTITY

  MI      PE(MI+1,1,N)/MAXR                                  . PE(MI+1,9,N)/MAXR
  MI-1    PE(MI,1,N)/MAXR                                 .         .
  MI-2    PE(MI-1,1,N)/MAXR                            .            .
   .             .                                  .               .
   .             .             .  .           .  .                  .
   .             .                                                  .
   3             .                 PE(II,J,N)                       .
   2             .                .           .  .                  .
   1             .             .                    .  .            .
   Ø      PE(1,1,N)/MAXR  . .                             .  . PE(1,9,N)/MAXR


             LAUNCH                                            SPACECRAFT
             ATTEMPTS. . . . . . . . . . . . . . . . . . . .   REFURB

EXPECTED
NUMBER         ME(1,N). . . . . . . . . . . . . . . . . . . ME(9,N)

STD.DEV.       STDE(1,N). . . . . . . . . . . . . . . . . . STDE(9,N)
```

ESTABLISHMENT & MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED

- TOTAL LAUNCH & SPACECRAFT COSTS
- TOTAL LAUNCH COSTS
- TOTAL SPACECRAFT COSTS
- LAUNCH & SPACECRAFT COSTS (LSC=X)
- LAUNCH COSTS (LSC=X)
- SPACECRAFT COSTS (LSC=X)

These three sets of reports are to be printed on request only, i.e., DETC=Y.

COST RANGE (MILLIONS OF DOLLARS)						
XXXX.XX--XXXX.XX	X.XXX	X.XXX	X.XXX	X.XXX		X.XXX
XXXX.XX--XXXX.XX	X.XXX	X.XXX	X.XXX	X.XXX	. . . .	X.XXX
XXXX.XX--XXXX.XX	X.XXX	X.XXX	X.XXX	X.XXX		X.XXX
. . .	.	.	.	.		.
. . .	.	.	.	.		.
. . .	.	.	.	.		.
XXXX.XX--XXXX.XX	X.XXX	X.XXX	X.XXX	X.XXX	. . . .	X.XXX
XXXX.XX--XXXX.XX	X.XXX	X.XXX	X.XXX	X.XXX		X.XXX
YEAR	1	2	3	4	. . . .	MAXN
EXPECTED COST	XXXX.X	XXXX.X	XXXX.X	XXXX.X	. . . .	XXXX.X
STD. DEV.	XXXX.X	XXXX.X	XXXX.X	XXXX.X	. . . .	XXXX.X

ESTABLISHMENT & MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

```
                                         (TOTAL LAUNCH & SPACECRAFT COSTS   K=3
           PROBABILITY OF INDICATED      {TOTAL LAUNCH COSTS                 K=1
                                         (TOTAL SPACECRAFT COSTS             K=2

   COST
   RANGE
 (MILLIONS
OF DOLLARS)

AMT(K)+[NOINT-1]*CSTIT(k)--AMT(K)+NOINT*CSTIT(K)    PT(K,NOINT,1)/MAXR...PT(K,NOINT,N)/MAXR
        .                        .                       .                    .
        .                        .                       .                    .
        .                        .                       .                    .
AMT(K)+2*CSTIT(K)         --AMT(K)+3*CSTIT(K)            .                    .
AMT(K)+CSTIT(K)           --AMT(K)+2*CSTIT(K)            .                    .
AMT(K)                    --AMT(K)+CSTIT(K)         PT(K,1,1)/MAXR . . . .PT(K,1,N)/MAXR

      YEAR                                               1 . . . . . . . . . . N

ESPECTED COST                                         MT(K,1). . . . . . .  MT(K,N)

STD.DEV.                                              STDT(K,1). . . . . .  STDT(K,N)
```

ESTABLISHMENT & MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED { LAUNCH & SPACECRAFT COSTS (LSC=LSC) K=3
LAUNCH COSTS (LSC=LSC) K=1
SPACECRAFT COSTS (LSC=LSC) K=2 }

COST RANGE (MILLIONS OF DOLLARS)		
AMN(K,LSC)+[NOINT-1]*CSTI(K,LSC)	--AMN(K,LSC)+NOINT*CSTI(K,LSC)	P(K,LSC,NOINT,1)/MAXR...P(K,LSC,NOINT,N)/MAXR
⋮	⋮	⋮ ⋮
AMN(K,LSC)+CSTI(K,LSC)	--AMN(K,LSC)+2*CSTI(K,LSC)	
AMN(K,LSC)	--AMN(K,LSC)+CSTI(K,LSC)	P(K,LSC,1,1,)/MAXR......P(K,LSC,1,N)/MAXR
YEAR		1 . . . . N
EXPECTED COST		MCST(K,LSC,1) . . . . . MCST(K,LSC,N)
STD. DEV.		STDCST(K,LSC,1) . . . . STDCST(K,LSC,N)

ESTABLISHMENT & MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

SPACECRAFT TYPE: XX

PROBABILITY OF INDICATED { LAUNCH ATTEMPTS / SPACECRAFT REQUIRED

QUANTITY					
XX	X.XXX	X.XXX	X.XXX	. . . . . .	X.XXX
XX	X.XXX	.	.		.
XX	.	.	.		.
XX	.	.	.		.
.	.	.	.		.
.	.	.	.		.
XX	X.XXX	X.XXX	X.XXX		X.XXX
YEAR	1	2	3	. . . .	MAXN
EXPECTED NUMBER	XX	XX	XX	. . . .	XX
STV.DEV.	XX	XX	XX	. . . .	XX

ESTABLISHMENT & MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

SPACECRAFT TYPE: LSC

PROBABILITY OF INDICATED LAUNCH ATTEMPTS

```
QUANTITY

 MI      PLA(MI+1,LSC,1)/MAXR . . . . . . . . PLA(MI+1,LSC,MAXN)/MAXR
MI-1     PLA(MI,LSC,1)/MAXR
MI-2     PLA(MI-1,LSC,1)/MAXR
 .
 .
 .                          PLA(II,LSC,N)
 .
 3
 2
 1
 Ø       PLA(1,LSC,1)/MAXR . . . . . . . . . PLA(1,LSC,MAXN)/MAXR

YEAR            1 . . . . . . . N . . . . . . . MAXN


EXPECTED
NUMBER   MLA(LSC,1) . . . . . . . . . . . . . MLA(LSC,MAXN)

STD.DEV. STDLA(LSC,1) . . . . . . . . . . . . STDLA(LSC,MAXN)
```

ESTABLISHMENT & MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PRESENT VALUE (MILLIONS OF DOLLARS)	PROBABILITY OF INDICATED PRESENT VALUE OF COST (DISCOUNT RATE=XX.X)
XXXXX.XX--XXXXX.XX	X.XXX
XXXXX.XX--XXXXX.XX	X.XXX
XXXXX.XX--XXXXX.XX	X.XXX
. .	.
. .	.
. .	.
XXXXX.XX--XXXXX.XX	X.XXX
EXPECTED PV	XXXXX.XX
STD. DEV.	XXXXX.XX

ESTABLISHMENT & MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SATELLITES

PRESENT VALUE (MILLIONS OF DOLLARS)		PROBABILITY OF INDICATED PRESENT VALUE OF COST (DISCOUNT RATE=DR)
PVN+[NOINT-1]*PVI	--PVN+NOINT*PVI	PPV(NOINT)/MAXR
.	.	.
.	.	.
.	.	.
		.
		.
PVN+2*PVI	--PVN+3*PVI	
PVN+PVI	--PVN+2*PVI	
PVN	--PVN+PVI	PPV(1)/MAXR
EXPECTED PV		MPV
STD. DEV.		STDPV

4.7 Optimum Scheduling Formulation

The problem is to satisfy the yearly demand for various sensor types in every year by launching spacecraft which transport a certain subset of the sensor types so that the overall program cost is kept to a minimum. If there were no random elements such as sensor failures, then the problem could be solved by considering the entire time frame of the program. In this analysis, however, the random element is incorporated and the decision as to which spacecraft to launch must be on a year-to-year basis (each year looking ahead to the future but taking into account what has happened in the past which will effect the future).

The variables for the problem consist of the number of new sensors which must be launched each year, the sensor mix which is carried on each spacecraft, and the spacecraft associated cost each year. In order to achieve a better conception of the potential launches, a "look-ahead" period beyond the current year is considered so that the costs will be minimized with respect to the "look-ahead" period and not just with respect to the current year. That is to say that it may be economically preferred to launch excess sensors in the current year to satisfy later year demands.

Formally stated as a linear integer program, the problem becomes:

Minimize:

$$\text{Total Cost} = \sum_{i=1}^{L}\sum_{j=1}^{m} (\text{Cost})_{i,j} \times (\text{Launch})_{i,j}$$

Subject to

$(\text{Launch})_{i,j}$ is integer valued for $i=1,2\ldots,L$; $j=1,2,$ $\ldots.,m$

and

$$\sum_{j=1}^{h} (\text{Sen})_{k,i} \times (\text{Launch})_{i,j} + (\text{Excess})_{k,j-1} - (\text{Excess})_{k,j}$$

$$= (\text{Dem})_{k,j}$$

$$\text{for } \begin{cases} i=1,2\ldots.,L \\ k=1,2,\ldots,n; \end{cases}$$

Where

i	=	index relating to spacecraft type
j	=	index relating to year of the "look-ahead" period (current=1)
k	=	index relating to sensor type
L	=	number of spacecraft types
m	=	number of years in the "look-ahead" period
n	=	number of sensor types
$\text{Cost}_{i,j}$	=	Cost to launch spacecraft i in year j
$\text{Launch}_{i,j}$	=	Number of spacecraft of type i to launch in year j
$\text{Sen}_{k,i}$	=	$\begin{cases} \emptyset \text{ if spacecraft } i \text{ does not carry sensor } k \\ 1 \text{ if spacecraft } i \text{ carries sensor } k \end{cases}$
$\text{Excess}_{k,j}$	=	number of excess sensor k in orbit in year j
$\text{Dem}_{k,j}$	=	demand for new launches of sensor k in year j

As the launch optimization occurs within a Monte Carlo simulation an efficient algorithm must be employed. Conventional linear integer programming algorithms are too time consuming to be considered, and a suboptimal choice procedure is employed. The problem is treated as a continuous linear program and a simple upwards rounding of any non-integer first year launches is employed. Although not always optimal, the rounded continuous solution will correspond to the best integer solution the vast majority of the time due to the nature of the setup of this specific problem.

5. SATIL 2 PROGRAM DESCRIPTION

The FORTRAN coding for SATIL 2 follows the flowchart (Section 4.5) very closely. The following is a description of the program implementation.

5.1 Organization

The computational variables, i.e., counters and sums, are initialized in one of three ways.

1. data statements
2. assignment statements
3. the subroutine ALIST1

The nominal values of the input variables are established in subroutine DFLTIN. The periodic reinitialization of variables within the Monte Carlo loop is done by subroutine ALIST2. Many of the NAMELIST input variables are arrays inputted as vectors in row rather than column order. The transposition of those arrays is accomplished by subroutine TRAMSP. The reliability equations are implemented in subroutine RELIAB. The linear programming algorithm is implemented in subroutine NOSAT which calls two assembly language routines. The output of the program is done by subroutine OUTPUT.

Those variables dimensioned in the flowchart by the number of Monte Carlo runs have been written out to disk on standard FORTRAN logical unit 2, and are then read back in after the Monte Carlo runs are completed.

5.2 Control Cards and Input

Standard FORTRAN compile, link-edit, and go cards are used if the source cards are being run and standard link-edit and go cards are used if object decks are used. A U.F4STAT SYSLIB card must be included in the link-edit step to locate and link subroutine TRAMSP. Inputs via NAMELIST should be entered in the appropriate place in the back of the decks.

6. SATIL 2 PROGRAM LISTING

```
C     SATIL02 LAUNCH SIMULATION                                         SATL0100
      EXTERNAL FIXUP
      REAL LCER,MPV
      INTEGER DEBUG      ,DETC
      REAL *8 MATRIX
      INTEGER *2 INDEXP,INDEXC
      DIMENSION MATRIX(16,28),INDEXP(16),INDEXC(28),COZT(5,25)
      DIMENSION PPP01(5),PPP02(5),PPP03(5),PPP04(5),PPP05(5),PPP06(5)
      DIMENSION PPP07(5),PPP08(5),PPP09(5),PPP10(5),PPP11(5),PPP12(5)
      DIMENSION PPP13(5),PPP14(5),PPP15(5),PPP16(5),PPP17(5),PPP18(5)
      DIMENSION PPP19(5),PPP20(5)
      INTEGER IPTLC(5,10), IIB(10), IX(5), LNCHS(5,25)                  SATL0200
      INTEGER IYB(5), NOSSC(5), IPEB(5), ISMIX(5)                       SATL0300
      INTEGER NOOP(10,25), NOSA(5,25),NEWSEN(10,25)
      INTEGER IPT(10),ISMIX(10,5),NOSEN(10,25),MAXN(5),NFAIL(5,20)      SATL0500
      INTEGER ILA(5,25), IRP(5,25), IB(5,25)                            SATL0600
      INTEGER IPI(5,25), IOR(5,25), IO(5,25)                            SATL0700
      INTEGER IPLR(5,25), IPMR(5,25), NOS(5,25)                         SATL0800
      INTEGER IS(5,20),ISS(10,5,20),IYEAR(5,20)                         SATL0900
      REAL C(3,5,25    ),CT(3,25    ),PE(25,9,25)
      REAL P(3,5,40,25),PT(3,40,25),PPV(40)                             SATL1100
      REAL RELS(10,25),PFS(10,25),RELB(5,25),AMTBF(10,5)                SATL1200
      REAL STANDI(10,5),AMEANL(10,5),AMTBS(10),STANDS(10),AMEANS(10)    SATL1300
      REAL LCS(10),CALC(10),PFB(5,25),AMAXC(10)                         SATL1400
      REAL AMINC(10),RANGE(10),UCP(5,10),PPP(5,20)                      SATL1500
      REAL UC(10),AMAXLC(5,10),AMINLC(5,10),LCELC(5,10)                 SATL1600
      REAL CALLC(5,10),RANGLC(5,10),UCPLC(5,5,10),SCCST(5,25)           SATL1700
      REAL  UCLT(5,10),PVF(25),LCST(5,25),LCEB(5),CALB(5)               SATL1800
      REAL AMAXB(5),AMINB(5),RANGEB(5),UCPB(5,5),UCPM(5)                SATL1900
      DIMENSION IMONT(5,25,9)
      INTEGER OPLCAP(5)
      REAL UCB(5),PBS(10),PBPF(10),PCROF(10)
      REAL            PBPS(10),POS(10),PPS( 5),POR(10),PPMO(10)
      INTEGER IPM(5,25)
      REAL PBAP(10),PPLPI(10),PPMFP(10),SIAC(3,5,25)                    SATL2200
      REAL POFBF(10)             ,PLA(25,5,25),PPL(25,5,25)
      REAL SUMSC(3,5,25),SUMCT(3,25),SUMSCT(3,25),SUMJ(9,25)            SATL2500
      REAL SUMSJ(9,25),SUMLA(5,25),SUMSLA(5,25),SUMPL(5,25)             SATL2600
      REAL SUMSPL(5,25),AMX(3,5),AMN(3,5),CSTI(3,5)                     SATL2700
      REAL AMXT(3),AMT(3),CSTIT(3),XCSM(3,5,25),ME(9,25)
      REAL STDE(9,25),MT(3,25),STDT(3,25),MLA(5,25)
      REAL STDCST(3,5,25),AMTBFT(5,10),STANDT(5,10),CALLCT(10,5)        SATL3000
      REAL AMINLT(10,5),AMAXLT(10,5),AMEANT(5,10)                       SATL3100
      INTEGER ISMIXT(5,10),NOSENT(25,10),IPTLCT(10,5),LNCHST(25,5)      SATL3200
      REAL STDLA(5,25),MPL(5,25),STDPL(5,25)                            SATL3300
      INTEGER NSEN01(25),NSEN02(25),NSEN03(25),NSEN04(25),NSEN05(25)    SATL3400
      INTEGER NSEN06(25),NSEN07(25),NSEN08(25),NSEN09(25),NSEN10(25)    SATL3500
      INTEGER IMIX01(5),IMIX02(5),IMIX03(5),IMIX04(5),IMIX05(5),IMIX06(5SATL3600
     2),IMIX07(5),IMIX08(5),IMIX09(5),IMIX10(5)                         SATL3700
      EQUIVALENCE(IMIX01,ISMIXT(1,1)),(IMIX02,ISMIXT(1,2))              SATL3800
      REAL AMEAN1(5),AMEAN2(5),AMEAN3(5),AMEAN4(5),AMEAN5(5)            SATL3900
      REAL AMXLC1(10),AMXLC2(10),AMXLC3(10),AMXLC4(10),AMXLC5(10)       SATL4000
      REAL AMNLC1(10),AMNLC2(10),AMNLC3(10),AMNLC4(10),AMNLC5(10)       SATL4100
      INTEGER IPTLC1(10),IPTLC2(10),IPTLC3(10),IPTLC4(10),IPTLC5(10)    SATL4200
      REAL CALLC1(10),CALLC2(10),CALLC3(10),CALLC4(10),CALLC5(10)       SATL4300
      INTEGER LNCHS1(25),LNCHS2(25),LNCHS3(25),LNCHS4(25),LNCHS5(25)    SATL4400
      REAL STAND1(5),STAND2(5),STAND3(5),STAND4(5),STAND5(5)            SATL4500
      REAL AMTBF1(5),AMTBF2(5),AMTBF3(5),AMTBF4(5),AMTBF5(5)            SATL4600
      EQUIVALENCE(IMIX03,ISMIXT(1,3)),(IMIX04,ISMIXT(1,4))              SATL4700
      EQUIVALENCE(IMIX05,ISMIXT(1,5)),(IMIX06,ISMIXT(1,6))              SATL4800
```

```
      EQUIVALENCE (STANDT,STANDL),(AMAXLC,AMAXLT),(AMEANL,AMEANT)       SATL4900
      EQUIVALENCE (ISMIX,ISMIXT),(LNCHS,LNCHST)                         SATL5000
      EQUIVALENCE(IMIX07,ISMIXT(1,7)),(IMIX08,ISMIXT(1,8))              SATL5100
      EQUIVALENCE(IMIX09,ISMIXT(1,9)),(IMIX10,ISMIXT(1,10))             SATL5200
      EQUIVALENCE (NSEN01,NOSENT(1,1)),(NSEN02,NOSENT(1,2))             SATL5300
      EQUIVALENCE (NSEN03,NOSENT(1,3)),(NSEN04,NOSENT(1,4))             SATL5400
      EQUIVALENCE (NSEN05,NOSENT(1,5)),(NSEN06,NOSENT(1,6))             SATL5500
      EQUIVALENCE (NSEN07,NOSENT(1,7)),(NSEN08,NOSENT(1,8))             SATL5600
      EQUIVALENCE (NSEN09,NOSENT(1,9)),(NSEN10,NOSENT(1,10))            SATL5700
      EQUIVALENCE (AMEAN1,AMEANT(1,1)),(AMEAN2,AMEANT(1,2))             SATL5800
      EQUIVALENCE (AMEAN3,AMEANT(1,3)),(AMEAN4,AMEANT(1,4))             SATL5900
      EQUIVALENCE (AMEAN5,AMEANT(1,5))                                  SATL6000
      EQUIVALENCE (AMXLC1,AMAXLT(1,1)),(AMXLC2,AMAXLT(1,2))             SATL6100
      EQUIVALENCE (AMXLC3,AMAXLT(1,3)),(AMXLC4,AMAXLT(1,4))             SATL6200
      EQUIVALENCE (AMXLC5,AMAXLT(1,5))                                  SATL6300
      EQUIVALENCE (AMNLC1,AMINLT(1,1)),(AMNLC2,AMINLT(1,2))             SATL6400
      EQUIVALENCE (AMNLC3,AMINLT(1,3)),(AMNLC4,AMINLT(1,4))             SATL6500
      EQUIVALENCE (AMNLC5,AMINLT(1,5))                                  SATL6600
      EQUIVALENCE (AMINLC,AMINLT)                                       SATL6700
      EQUIVALENCE(AMTBFT,AMTBF)                                         MBS
      EQUIVALENCE(NOSEN,NOSENT)                                         SATL6800
      EQUIVALENCE (IPTLC1,IPTLCT(1,1)),(IPTLC2,IPTLCT(1,2))             SATL6900
      EQUIVALENCE (IPTLC3,IPTLCT(1,3)),(IPTLC4,IPTLCT(1,4))             SATL7000
      EQUIVALENCE (IPTLC5,IPTLCT(1,5))                                  SATL7100
      EQUIVALENCE (IPTLC,IPTLCT)                                        SATL7200
      EQUIVALENCE (CALLC1,CALLCT(1,1)),(CALLC2,CALLCT(1,2))             SATL7300
      EQUIVALENCE (CALLC3,CALLCT(1,3)),(CALLC4,CALLCT(1,4))             SATL7400
      EQUIVALENCE (CALLC5,CALLCT(1,5))                                  SATL7500
      EQUIVALENCE (CALLC,CALLCT)                                        SATL7600
      EQUIVALENCE (LNCHS1,LNCHST(1,1)),(LNCHS2,LNCHST(1,2))             SATL7700
      EQUIVALENCE (LNCHS3,LNCHST(1,3)),(LNCHS4,LNCHST(1,4))             SATL7800
      EQUIVALENCE (LNCHS5,LNCHST(1,5))                                  SATL7900
      EQUIVALENCE (STAND1,STANDT(1,1)),(STAND2,STANDT(1,2))             SATL8000
      EQUIVALENCE (STAND3,STANDT(1,3)),(STAND4,STANDT(1,4))             SATL8100
      EQUIVALENCE (STAND5,STANDT(1,5))                                  SATL8200
      EQUIVALENCE (AMTBF1,AMTBFT(1,1)),(AMTBF2,AMTBFT(1,2))             SATL8300
      EQUIVALENCE (AMTBF3,AMTBFT(1,3)),(AMTBF4,AMTBFT(1,4))             SATL8400
      EQUIVALENCE (AMTBF5,AMTBFT(1,5))                                  SATL8500
      EQUIVALENCE(PPP(1, 1),PPP01(1))
      EQUIVALENCE(PPP(1,02),PPP02(1))
      EQUIVALENCE(PPP(1,03),PPP03(1))
      EQUIVALENCE(PPP(1,04),PPP04(1))
      EQUIVALENCE(PPP(1,05),PPP05(1))
      EQUIVALENCE(PPP(1,06),PPP06(1))
      EQUIVALENCE(PPP(1,07),PPP07(1))
      EQUIVALENCE(PPP(1,08),PPP08(1))
      EQUIVALENCE(PPP(1,09),PPP09(1))
      EQUIVALENCE(PPP(1,10),PPP10(1))
      EQUIVALENCE(PPP(1,11),PPP11(1))
      EQUIVALENCE(PPP(1,12),PPP12(1))
      EQUIVALENCE(PPP(1,13),PPP13(1))
      EQUIVALENCE(PPP(1,14),PPP14(1))
      EQUIVALENCE(PPP(1,15),PPP15(1))
      EQUIVALENCE(PPP(1,16),PPP16(1))
      EQUIVALENCE(PPP(1,17),PPP17(1))
      EQUIVALENCE(PPP(1,18),PPP18(1))
      EQUIVALENCE(PPP(1,19),PPP19(1))
      EQUIVALENCE(PPP(1,20),PPP20(1))
C
C
```

```
      COMMON/OUTS/MI,PE,MAXR,MF,STDE,AMT,NOINT,CSTIT,P,MT,STDT,MCST,
     1   STDCST,PLA,MAXN,MLA,STDLA,PVN,PVI,PPV,MPV,STDPV,ITL,DETC
     2  ,PT,PPL,MPL,STDPL,AMN,CSTI,MAXLSC,DR
      COMMON/PRNT/DEBUG
      COMMON/MONT/ILA,IB,IO,IPM,IPL,IBR,IOR,IPMR,IPLR
      COMMON/LINEAR/ COST,LS,LSC,N3,N,ISMIX,NEWSEN
      COMMON/LAUNCH/KSAT(5),ICOST
      COMMON/DISK/C,CT,ANPV
      EQUIVALENCE(IMONT(1,1,1),ILA(1,1))
C
C
      ALP(X)=-1.+(ALOG10(X)-1.699)/.301
      DEV(X,Y)=SQRT(Y/AMAXP-Y**2)
C
      DATA UCLC,ICELC,LCF/110*0./
      DATA NOSA,NOS/250*0/
      DATA ITS,IXP,IX/15*0,5*-5/
      DATA MAXI/25/                                                     MBS
      DATA AMTBF/50*5./                                                 MBS
      DATA INDEMP,INDEMC/44*0/
      DATA MATRIX/448*0.0D0/
      DATA PPP01/.5,.25,.15,.07,.03/
      DATA PPP02/.3,.25,.2,.15,.1/
      DATA PPP03/.3,.3,.2,.13,.07/
      DATA PPP04/.35,.4,.15,.07,.03/
      DATA PPP05/.21,.32,.27,.15,.05/
      DATA PPP06/.23,.3,.23,.16,.08/
      DATA PPP07/.25,.35,.25,.1,.05/
      DATA PPP08/.16,.49,.24,.09,.02/
      DATA PPP09/.12,.32,.32,.17,.07/
      DATA PPP10/.15,.34,.37,.12,.02/
      DATA PPP11/.2,.2,.2,.2,.2/
      DATA PPP12/.15,.22,.26,.22,.15/
      DATA PPP13/.1,.25,.3,.25,.1/
      DATA PPP14/.08,.25,.34,.25,.08/
      DATA PPP15/.05,.25,.4,.25,.05/
      DATA PPP16/.1,.2,.4,.2,.1/
      DATA PPP17/.03,.3,.34,.3,.03/
      DATA PPP18/.05,.2,.5,.2,.05/
      DATA PPP19/.03,.2,.54,.2,.03/
      DATA PPP20/.03,.07,.8,.07,.03/
      NAMELIST /INPUT/ MAXN,MAXLSC,MAXLS,MAXNB,MAXLR,MAXIE,MAXR,MAXI,   SATL9400
     2  NOINT,NSEN01,NSEN02,NSEN03,NSEN04,NSEN05,NSEN06,NSEN07,         SATL9500
     2  NSEN08,NSEN09,NSEN10,IMIX01,IMIX02,IMIX03,IMIX04,IMIX05,IMIX06, SATL9600
     3 IMIX07,IMIX08,IMIX09,IMIX10,IBMIX,AMTBF1,AMTBF2,AMTBF3,AMTBF4,   SATL9700
     4 AMTBF5,STAND1,STAND2,STAND3,STAND4,STAND5,AMEAN1,AMEAN2,AMEAN3,  SATL9800
     5  AMEAN4,AMEAN5,AMTBS,STANDS,AMEANS,AMAXC,AMINC,IPI,CALC,AMAXB,   SATL9900
     6 AMINB,IPTB,CALB,AMAXM,AMINM,IPTM,CALR,AMXLC1,AMXLC2,AMXLC3,      SATL0000
     7  AMXLC4,AMXLC5,AMNLC1,AMNLC2,AMNLC3,AMNLC4,AMNLC5,IPTLC1,IPTLC2, SATL0100
     8  IPTLC3,IPTLC4,IPTLC5,CALLC1,CALLC2,CALLC3,CALLC4,CALLC5,LNCHS1, SATL0200
     9 LNCHS2,LNCHS3,LNCHS4,LNCHS5,ORBCAP,PPS,PBS,PBRS,PBRF,POS,POROF,  SATL0300
     A  PORBF,POR,PPMC,PPMP,PPMFP,PPLRR,MAXM,NN,DF,DETC          ,
     B   PPP01,PPP02,PPP03,PPP04,PPP05,PPP06,PPP07,PPP08,PPP09,PPP10,
     C   PPP11,PPP12,PPP13,PPP14,PPP15,PPP16,PPP17,PPP18,PPP19,PPP20
     D,DEBUG
C
C                                                                       SATL0500
C     INITIALIZE INPUT DATA TO DEFAULT VALUES                           SATL0600
C
C
```

```
      MI=0
      NOINT=25
      DO 5910 K=1,3
      DO 5913 N=1,25
      CT(K,N)=0.
      SUMCT(K,N)=0.
 5913 SUMSCT(K,N)=0.
      AMXT(K)=-999.
      AMT(K)=10.E10
      DO 5910 LSC=1,5
      AMX(K,LSC)=-999.
 5910 AMN(K,LSC)=10.E10
      PVX=-999.
      PVN= 10.E10
      DEBUG=0
      N3=3
      CALL DFLTIN(          PPMP,                                       MBS001
     1NOSEN,ISMIX,IBMIX,AMTBF,STANDL,AMEANL,AMTBS,STANDS,AMEANS,AMAXC,  SATL0800
     2  AMINC,IPT,CALC,AMAXB,AMINB,IPTB,CALB,AMAXM,AMINM,IPTM,CALR,     SATL0900
     3  AMAXLC,AMINLC,IPTLC,CALLC,LNCHS,ORBCAP,PPS,PPB,PBRS,PBRF,POS,   SATL1000
     3  PORBF,PORBF,POR,PPMC,PPMRP,PPLRB,MAXM,NN,DT,DETC)               SATL1100
C
C     NAMELIST INPUT                                                    SATL1200
C
      READ(5,INPUT)                                                     SATL1300
      WRITE(6,INPUT)
      WRITE(6,700)
  700 FORMAT(1H1)
      WRITE(6,328)
  328 FORMAT(10X,'PPP')
      DO 326 I=1,20
  326 WRITE(6,327) (PPP(II,I),II=1,5)
  327 FORMAT(3X,5F7.2)
      WRITE(6,700)
C     VALIDATE                                                          SATL1500
C ******* *********                                                     SATL1600
      CALL START('*')                                                   SATL1700
      CALL TRANSP(AMTBPT,5,10,STAR4)                                    SATL1800
      CALL TRANSP(LNCHST,25,5,STAR4)                                    SATL1900
      CALL TRANSP(STANDT,5,10,STAR4)                                    SATL2000
      CALL TRANSP(CALLCT,10,5,STAR4)                                    SATL2100
      CALL TRANSP(IPTLCT,10,5,STAR4)                                    SATL2200
      CALL TRANSP(AMINLT,10,5,STAR4)                                    SATL2300
      CALL TRANSP(AMAXLT,10,5,STAR4)                                    SATL2400
      CALL TRANSP(AMEANT,5,10,STAR4)                                    SATL2500
      CALL TRANSP(ISMIXT,5,10,STAR4)                                    SATL2600
      CALL TRANSP(NOSENT,25,10,STAR4)                                   SATL2700
C
      WRITE(6,343)
  343 FORMAT(   ' ISMIX')
      DO 344 I=1,10
  344 WRITE(6,345) (ISMIX(I,J),J=1,5)
  345 FORMAT(3X,5I4)
C   INITIALIZE AS PER LIST #1                                           SATL2800
C
      CALL          ALIST1(SUMPL,SUMSPL,P,PPL,PT,PPV,ANPV,SUMPV,SUMSPV,
     1 MAXIS,MAXN,MAXNB,MAXLSC         ,PFS         ,PFB,SUMLA,SUMSLA,MLA,  SATL3000
     2 MPL,SUMC,SUMSC,PLA,SUMJ,SUMSJ,PD)                                SATL3100
C                                                                       SATL3200
C                                                                       SATL3300
```

```
C     COMPUTATION OF BUS RELIABILITY & PROB. OF FAILURE/YEAR                SATL3400
C                                                                           SATL3500
      CALL RELIAB(MAXLB,
     1 MAXNB,MAXN,PFB,RELB,AMTBF,STANDL,AMEANL,MAXLS,PFS,RELS,AMTBS,        SATL3700
     2  STANDS,AMEANS)                                                      SATL3800
      WRITE(6,348)
  348 FORMAT(/' PFB')
      DO 346 I=1,5
  346 WRITE(6,347) (PFB(I,J),J=1,10)
  347 FORMAT(10X,10F6.3)
      WRITE(6,349)
  349 FORMAT(/' PFS')
      DO 350 I=1,10
  350 WRITE(6,347) (PFS(I,J),J=1,10)
      IF(DEBUG.EQ.0) GO TO 351
      DO 352 I=1,25
      DO 353 J=1,5
  353 PFB(J,I)=0.
      DO 354 J=1,10
  354 PFS(J,I)=0.
  352 CONTINUE
  351 CONTINUE
C
C
C.......LEARNING CURVE EXPONENTS FOR SENSORS                                 SATL3900
C
      DO 8020 LS=1,MAXLS
 8020 LCE(LS)=ALP(CALC(LS))
      LCEF=ALP(CALF)
      DO 8021 NB=1,MAXNB
 8021 LCEB(NB)=ALP(CALB(NB))
      DO 8022 LSC=1,MAXLSC
      DO 8023 LS=1,MAXLS
 8023 NOSSC(LSC)=NOSSC(LSC)+ISMIX(LS,LSC)
 8022 CONTINUE
C                                                                           SATL4300
C.......... 0 2                                                             SATL4400
C                                                                           SATL4500
      DO 1029 LS=1,MAXLS                                                    SATL4600
1029  ITS(LS)=0                                                             SATL4700
      ITL=0                                                                 SATL4800
      DO 1030 N=1,MAXN                                                      SATL4900
      DO 1031 LS=1,MAXLS                                                    SATL5000
      IF(NOSEN(LS,N).LE.0)GOTO 1031                                         SATL5500
      IF(ITL.EQ.0)ITL=N                                                     SATL5600
      IF(ITS(LS).EQ.0) ITS(LS)=N                                            SATL5700
1031  CONTINUE                                                              SATL6000
1030  CONTINUE                                                              SATL6100
C
C     COMPUTE DISCOUNT FACTOR
C
      MAXNNN=MAXN+NN
      DO 1040 N=1,MAXNNN
 1040 PVF(N)=1.0/(1.0+.01*DF)**(N-1)
C
C............START OF ACTIVITY FOR SPACECRAFT AND BUSES                     SATL7000
C
      DO 1044 LSC=1,MAXLSC                                                  SATL7100
      IX(LSC)=-5                                                            SATL7200
      DO 1045 LS=1,MAXLS                                                    SATL7300
```

```
      IRAD=ITS(IS)*ISMIX(LS,LSC)                                        SATL7400
      IF(IRAD.GT.IX(LSC))IX(LSC)=IRAD                                   SATL7500
 1045 CONTINUE                                                          SATL7900
 1044 CONTINUE                                                          SATL8000
      DO 1047 NB=1,MAXNB                                                SATL8100
 1047 IXB(NB)=ITL                                                       SATL8400
C
C
C
C.........@ 3                                                           SATL8500
C.........LAUNCH COST LEARNING EXPONENT                                 SATL8600
C
      DO 1050 IE=1,MAXIE                                                SATL8700
      DO 1050 LSC=1,MAXLSC                                              SATL8800
 1050 LCELC(LSC,IE)=ALR(CALLC(LSC,IE))
C
      WRITE(6,355)LCE
  355 FORMAT(/' LCE=',10E12.4)
      WRITE(6,356)LCER
  356 FORMAT(/' LCER=',1E12.4)
      WRITE(6,357)LCEB
  357 FORMAT(/' LCEB=',5E12.4)
      WRITE(6,358)
  358 FORMAT(/' LCELC')
      WRITE(6,359) ((LCELC(I,J),I=1,5),J=1,10)
  359 FORMAT(3X,10E12.4)
      WRITE(6,360)ITL
  360 FORMAT(/' ITL=',1I4)
      WRITE(6,361)ITS
  361 FORMAT(/' ITS=',10I4)
      WRITE(6,362)IX
  362 FORMAT(/' IX=',5I4)
      WRITE(6,363)IXB
  363 FORMAT(/' IXB=',5I4)
      WRITE(6,364) (PVF(N),N=1,10)
  364 FORMAT(/' PVF=',10E12.4)
C.......@ 4                                                             SATL9100
      DO 1059 LS=1,MAXLS
      IF(AMAXC(LS).EQ.AMINC(LS))GOTO 1059
      RANGE(LS)=(AMAX C(LS)-AMIN C(LS))*.2                              SATL9300
      IF(IPT(LS).LE.20)GOTO 1051                                        SATL9400
      DO 1052 I=1,5                                                     SATL9500
 1052 UCP(I,LS)=PPP(6-I,IPT(LS)-20)                                     SATL9600
      GOTO 1053                                                         SATL9700
 1051 DO 1054 I=1,5                                                     SATL9800
 1054 UCP(I,LS)=PPP(I,IPT(LS))                                          SATL9900
 1053 CONTINUE                                                          SATL0000
 1059 CONTINUE
C
C.........@ 3A                                                          SATL0700
C.........@ 4A                                                          SATL0900
      DO 36 NB=1,MAXNB
      IF(AMAXB(NB).EQ.AMINB(NB)) GO TO 38
      RANGEB(NB)=(AMAXB(NB)-AMINB(NB))*.2
C.........SET UP PROBABILITY DISTN OF BUS COSTS                         SATL1200
      IF(IPTB(NB).LE.20) GOTO 1061                                      SATL1300
      DO 1062 I=1,5                                                     SATL1400
 1062 UCPB(I,NB)=PPP(6-I,IPTB(NB)-20)                                   SATL1500
      GOTO 1063                                                         SATL1600
 1061 DO 1064 I=1,5                                                     SATL1700
```

```
1064  UCPB(I,NB)=PPP(I,IPTB(NB))                                              SATL1800
1063  CONTINUE                                                                SATL1900
38    CONTINUE                                                                SATL2300
C
C
C     AT 3B
C
      IF(AMAXM.EQ.AMINM) GOTO 39                                              SATL2700
      RANGEM=(AMAXM-AMINM)*.2                                                 SATL2800
C.......SET UP PROB. DISTN. OF S/C MAINT. & REPAIR COSTS                       SATL2900
C....... (AS % OF S/C COST)                                                    SATL3000
      IF(IPTM.LE.20) GOTO 1070                                                SATL3100
      DO 1071 I=1,5                                                           SATL3200
1071  UCPM(I)=PPP(6-I,IPTM-20)                                                SATL3300
      GOTO 1072                                                               SATL3400
1070  DO 1074 I=1,5                                                           SATL3500
1074  UCPM(I)=PPP(I,IPTM)                                                     SATL3600
1072  CONTINUE                                                                SATL3700
C
C     AT 3C
C
   39 DO 34 IE=1,MAXIE
      DO 36 LSC=1,MAXLSC
      IF(AMAXLC(LSC,IE).EQ.AMINLC(LSC,IE)) GOTO 36                            SATL4600
      RANGLC(LSC,IE)=(AMAXLC(LSC,IE)-AMINLC(LSC,IE))*.2                       SATL4700
C.........SET UP PROB.DISTN. OF LAUNCH COSTS                                   SATL4800
      IF(IPTLC(LSC,IE).LE.20) GOTO 1080                                       SATL4900
      DO 1081 I=1,5                                                           SATL5000
1081  UCPLC(I,LSC,IE)=PPP(6-I,IPTLC(LSC,IE)-20)                               SATL5100
      GOTO 1082                                                               SATL5200
1080  DO 1083 I=1,5                                                           SATL5300
1083  UCPLC(I,LSC,IE)=PPP(I,IPTLC(LSC,IE))                                    SATL5400
1082  CONTINUE                                                                SATL5500
   36 CONTINUE
   34 CONTINUE
C
      NNN=MAXN+NN                                                             SATL6500
      DO 1088 N=MAXN,NNN                                                      SATL6800
      DO 1088 LS=1,MAXLS                                                      SATL6900
1088  NOSEN(LS,N)=NOSEN(LS,MAXN)                                              SATL7000
      WRITE(6,377)
  377 FORMAT(/' NOSEN=')
      WRITE(6,378) ((NOSEN(I,J),J=1,25),I=1,10)
  378 FORMAT(3X,25I3)
C*******************************************************************
C
C
C
C                                                                             SATL7100
C..................START OF MONTE CARLO LOOP                                   SATL7200
C                                                                             SATL7300
C........D 7                                                                   SATL7400
C........D S                                                                   SATL7600
C ************************************                                        SATL7700
      DO 9001 NR=1,MAXR
C          INITIALIZE AS PER LIST #2                                          SATL7800
C
      CALL ALIST2(    COZT,
     1 MAXLSC,MAXLS,MAXR,IX,SCCST,LCST,ILA,IB,IBP,IPL,IO,IOR,IPM,IPLR,
     2 IPMR,                  NOOP,    NFAIL,IS,ISS)
```

```
C ****************************
      DO 9010 K=1,3
      DO 9010 N=1,25
      CT(K,N)=0.
      DO 9010 LSC=1,5
 9010 C(K,LSC,N)=0.
      ANPV=0.
C
      DO 1091 LS=1,MAXLS
      IF(AMAXC(LS).NE.AMINC(LS)) GOTO 1092
      UC(LS)=AMAXC(LS)
      GOTO 1091
 1092 ACC=0.0
      RN=RNDY5(DUMMY)
      DO 1093 I=1,5
      ACC=ACC+UCP(I,LS)
      IF(ACC.LT.RN) GOTO 1093
C
C.......SENSOR COST COMPUTATION
C
      UC(LS)=AMINC(LS)+RANGE(LS)*(I-1)+(RN-ACC+UCP(I,LS))*RANGE(LS)
     1/UCP(I,LS)
      GOTO 1091
 1093 CONTINUE
 1091 CONTINUE
C
C.......@ 9
      DO 2001 NB=1,MAXNB
      IF(AMAXB(NB).NE.AMINB(NB))GOTO 2002
      UCB(NB)=AMAXB(NB)
      GOTO 2001
 2002 ACC=0.0
      RN=RNDY5(DUMMY)
      DO 2003 I=1,5
      ACC=ACC+UCPB(I,NB)
      IF(ACC.LT.RN)GOTO 2003
      UCB(NB)=AMINB(NB)+RANGEB(NB)*(I-1)+(RN-ACC+UCPB(I,NB))*RANGEB(NB)
     1/UCPB(I,NB)
      GOTO 2001
 2003 CONTINUE
 2001 CONTINUE
C
C
C............S/C REFURBISHMENT AND MAINT. COST COMPUTATION
C........9 9A
C
      IF(AMAXM.NE.AMINM) GOTO 2006
      UCM=AMAXM
      GOTO 2009
 2006 ACC=0.0
      RN=RNDY5(DUMMY)
      DO 2007 I=1,5
      ACC=ACC+UCPM(I)
      IF(ACC.LT.RN) GOTO 2007
      UCM=AMINM+RANGEM*(I-1)+(RN-ACC+UCPM(I))*RANGEM/UCPM(I)
      GOTO 2009
 2007 CONTINUE
 2009 CONTINUE
C
C     10
```

```
C
      DO 2020 IE=1,MAXIE
      DO 2021 LSC=1,MAXLSC
      IF(AMAXLC(LSC,IE).NE.AMINLC(LSC,IE)) GOTO 2022
      UCLC(LSC,IE)=AMAXLC(LSC,IE)
      GO TO 2021
 2022 ACC=0.
      RN=RNDY5(DUMMY)
      DO 2023 I=1,5
      ACC=ACC+UCPLC(I,LSC,IE)
      IF(ACC.GE.RN) GO TO 2024
 2023 CONTINUE
 2024 CONTINUE
      UCLC(LSC,IE)=AMINLC(LSC,IE)+RANGLC(LSC,IE)*FLOAT(I-1)
     2   +(RN-ACC+UCPLC(I,LSC,IE))*RANGLC(LSC,IE)/UCPLC(I,LSC,IE)
 2021 CONTINUE
 2020 CONTINUE
C
C........# 11
C.................. S/C COST IN YEAR N (BUS+SENSOR)
C
      DO 2030 LSC=1,MAXLSC
      NQ=IX(LSC)
      DO 2031 N=NQ,MAXN
      SUM=0
      DO 2032 LS=1,MAXLS
      IF(ITS(LS).GT.N) GO TO 2032
      F=N-ITS(LS)+1
      SUM=SUM+FLOAT(ISMIX(LS,LSC))*UC(LS)*F**LCE(LS)
 2032 CONTINUE
      IF(ITL.GT.N) GO TO 2031
      F=N-ITL+1
      SCCST(LSC,N)=UCB(IBMIX(LSC))*(F       )**LCEB(IBMIX(LSC))+SUM
 2031 CONTINUE
 2030 CONTINUE
C
      NNN=MAXN+NN
      DO 2033 N=MAXN,NNN
      DO 2033 LSC=1,MAXLSC
 2033 SCCST(LSC,N)=SCCST(LSC,MAXN)
C
C
      DO 2034 LSC=1,MAXLSC
      NQ=IX(LSC)
      DO 2035 N=NQ,MAXN
      IF(LNCHS(LSC,N).NE.LNCHS(LSC,NQ)) GO TO 2036
      FN=N-IX(LSC)+1
      GO TO 2037
 2036 FN=1
      IX(LSC)=N
 2037 LCST(LSC,N)=UCLC(LSC,LNCHS(LSC,N))*FN**(LCELC(LSC,LNCHS(LSC,N)))
 2035 CONTINUE
 2034 CONTINUE
      DO 2038 N=MAXN,NNN
      DO 2038 LSC=1,MAXLSC
 2038 LCST(LSC,N)=LCST(LSC,MAXN)
      DO 9008 N=1,NNN
      PVFN=PVF(N)
      DO 9008 LSC=1,MAXLSC
 9008 COST(LSC,N)=PVFN*(SCCST(LSC,N)+LCST(LSC,N))
```

```
C
      IF(MAXR.NE.1) GO TO 5900
      WRITE(6,365)
  365 FORMAT(/' SCCST')
      DO 366 I=1,5
  366 WRITE(6,367) (SCCST(I,J),J=1,10)
  367 FORMAT(3X,10F6.1)
      WRITE(6,368)
  368 FORMAT(/' LCST')
      DO 369 I=1,5
  369 WRITE(6,367) (LCST(I,J),J=1,10)
      WRITE(6,370)
  370 FORMAT(/' COZT')
      DO 371 I=1,5
  371 WRITE(6,367) (COZT(I,J),J=1,10)
      WRITE(6,372)UCB
  372 FORMAT(/' UCB=',2X,5F6.1)
      WRITE(6,373)UCM
  373 FORMAT(/' UCM=',1F6.1)
      WRITE(6,374)
  374 FORMAT(/' UCLC')
      DO 375 I=1,5
  375 WRITE(6,376) (UCLC(I,J),J=1,10)
  376 FORMAT(5X,10F6.1)
C
C     TIME LOOP
C
C.........D 12
 5900 DO 9002 N=ITL,MAXN
      N1=N+1
      IF(N.NE.ITL) GO TO 2061
C
C
C.......    COMPUTE NOSA
      LSC=MAXLSC
      LS=MAXLS
      MMAT=LS*N3+1
      NMAT=(LSC+LS)*N3+1
      DO 9313 I10=1,10
      DO 9312 I25=1,25
      NEWSEN(I10,I25)=NOSEN(I10,I25)-NOOP(I10,N)
      IF(NEWSEN(I10,I25).LT.0) NEWSEN(I10,I25)=0
 9312 CONTINUE
      DO 9314 I25=N1,25
      J25=25+N1-I25
      NEWSEN(I10,J25)=NEWSEN(I10,J25)-NEWSEN(I10,J25-1)
      IF(NEWSEN(I10,J25).LT.0) NEWSEN(I10,J25)=0
 9314 CONTINUE
 9313 CONTINUE
      CALL NOSAT(MATRIX,INDEXR,INDEXC,MMAT,NMAT)
      IF(MAXR.NE.1) GO TO 5902
      WRITE(6,332) N
  332 FORMAT(//' N= ',1I4)
      WRITE(6,339) (NOOP(I,N),I=1,10)
  339 FORMAT('   NOOP= ',10I3)
      WRITE(6,329)
  329 FORMAT(' NEWSEN')
      DO 330 I=1,10
  330 WRITE(6,331) (NEWSEN(I,J),J=1,25)
  331 FORMAT(3X,25I3)
```

```
      WRITE(6,333)KSAT
  333 FORMAT(' KSAT= ',5I3)
 5902 DO 9005 LSC=1,MAXLSC
      NOSA(LSC,N)=KSAT(LSC)
 9005 CONTINUE
C
C
      GO TO 13
 2061 CONTINUE
      DO 2062 LSC=1,MAXLSC
      MM=MAXM(LSC)
      DO 2063 M=1,MM
      IF(IS(LSC,M).NE.0) GO TO 2063
      IF(NOSA(LSC,N-1).LE.0) GO TO 2062
      IS(LSC,M)=1
      DO 2064 LS=1,MAXLS
      IF(ISMIX(LS,LSC).LE.0) GO TO 2064
      ISS(LS,LSC,M)=1
 2064 CONTINUE
      NOSA(LSC,N-1)=NOSA(LSC,N-1)-1
      IYEAR(LSC,M)=N
 2063 CONTINUE
      WRITE(6,89770)LSC,N,MAXR
89770 FORMAT(' ALL S/C USED - LSC,N,MAXR= ',3I6)
 2062 CONTINUE
C
C.......@ 15
C
      DO 2070 LSC=1,MAXLSC
      MM=MAXM(LSC)
      DO 2071 M=1,MM
      IF(IS(LSC,M).EQ.0) GO TO 2071
      RN=RNDY5(DUMMY)
      IF(RN.GT.PFB(IBMIX(LSC),N-IYEAR(LSC,M)+1)) GO TO 2078
C..... BUS FAILS
      IS(LSC,M)=0
      DO 2072 LS=1,MAXLS
 2072 ISS(LS,LSC,M)=0
      GO TO 2071
 2078 CONTINUE
C.......@ 16
      DO 2081 LS=1,MAXLS
      IF(ISMIX(LS,LSC).LE.0) GO TO 2081
      IF(ISS(LS,LSC,M).NE.1) GO TO 2082
      RN=RNDY5(DUMMY)
      IF(RN.LE.PFS(LS,N-IYEAR(LSC,M)+1) ) GO TO 2082
      NOOP(LS,N)=NOOP(LS,N)+1
      GO TO 2081
 2082 NFAIL(LSC,M)=NFAIL(LSC,M)+1
      ISS(LS,LSC,M)=0
 2081 CONTINUE
      IF(NOSSC(LSC).GT.NFAIL(LSC,M)) GO TO 2089
      IS(LSC,M)=0
 2089 CONTINUE
 2071 CONTINUE
 2070 CONTINUE
C
C.......COMPUTE NOSA(LSC,M)
C
C
```

```
      LSC=MAXLSC
      LS=MAXLS
      MMAT=LS*N3+1
      NMAT=(LSC+LS)*N3+1
      DO 9353 I10=1,10
      DO 9352 I25=1,25
      NEWSEN(I10,I25)=NOSEN(I10,I25)-NOOP(I10,N)
      IF(NEWSEN(I10,I25).LT.0) NEWSEN(I10,I25)=0
 9352 CONTINUE
      DO 9316 I25=N1,25
      J25=25+N1-I25
      NEWSEN(I10,J25)=NEWSEN(I10,J25)-NEWSEN(I10,J25-1)
      IF(NEWSEN(I10,J25).LT.0) NEWSEN(I10,J25)=0
 9316 CONTINUE
 9353 CONTINUE
      CALL NOSAT(MATRIX,INDEXR,INDEXC,MMAT,NMAT)
      IF(MAXP.NE.1) GO TO 5901
      WRITE(6,332) N
      WRITE(6,329)
      WRITE(6,339) (NOOP(I,N),I=1,10)
      DO 335 I=1,10
  335 WRITE(6,331) (NEWSEN(I,J),J=1,25)
      WRITE(6,333) KSAT
 5901 DO 9006 LSC=1,MAXLSC
      NOSA(LSC,N)=KSAT(LSC)
 9006 CONTINUE
C
C
   13 CONTINUE
      DO 8883 LSC=1,MAXLSC
 8883 NOS(LSC,N)=NOSA(LSC,N)
C
C
C     SPACECRAFT LOOP
C
      LSC=1
 2079 CONTINUE
      IF(NOS(LSC,N).NE.0) GO TO 2080
 2075 LSC=LSC+1
      IF(LSC.EQ.MAXLSC) GO TO 2076
      GO TO 2079
C
C
C     START OF LAUNCH SEQUENCE
C
C..... 3 20
 2080 CONTINUE
 3020 II=LNCHS(LSC,N)
      ILA(LSC,N)=ILA(LSC,N)+1
      RN=RNDY5(DUMMY)
      IF(RN.GE.PBS(II)) GO TO 2090
C......BOOSTER SUCCESS
      RN=RNDY5(DUMMY)
      IF(RN.GE.PBRS(II)) GO TO 2091
C........BOOSTER RECOVERED
      IBR(LSC,N)=IBR(LSC,N)+1
      GO TO 2092
 2091 IB(LSC,N)=IB(LSC,N)+1
 2092 RN=RNDY5(DUMMY)
      IF(RN.LT.POS(II)) GO TO 3023
```

```
C........ORBITER ABORT
      GO TO 3001
 2090 RN=RNDY5(DUMMY)
      IF(RN.LT.PBRF(II)) GO TO 3000
      IB(LSC,N)=IB(LSC,N)+1
      GO TO 3001
C..... BOOSTER RECOVERED
 3000 IBR(LSC,N)=IBR(LSC,N)+1
 3001 RN=RNDY5(DUMMY)
      IF(RN.GE.PORGF(II)) GO TO 3002
      IOR(LSC,N)=IOR(LSC,N)+1
      GO TO 3020
 3002 IPL(LSC,N)=IPL(LSC,N)+1
      IO(LSC,N)=IO(LSC,N)+1
      IF(ORBCAP(LSC).EQ.1) GO TO 3020
      IPM(LSC,N)=IPM(LSC,N)+1
      GO TO 3020
 3023 CONTINUE
C.....B 23
      IF(ORBCAP(LSC).NE.1) GO TO 3034
      RN=RNDY5(DUMMY)
      IF(RN.GE.PPS(LSC)) GO TO 3030
C.......PAYLOAD OK
      RN=RNDY5(DUMMY)
      IF(RN.GE.POF(II)) GO TO 3031
C.........ORBITER RECOVERED
      IOR(LSC,N)=IOR(LSC,N)+1
      GO TO 3032
 3031 IO(LSC,N)=IO(LSC,N)+1
 3032 IPL(LSC,N)=IPL(LSC,N)+1
      GO TO 3035
 3030 RN=RNDY5(DUMMY)
      IF(RN.LT.POF(II)) GO TO 3036
      IO(LSC,N)=IO(LSC,N)+1
      IPL(LSC,N)=IPL(LSC,N)+1
      GO TO 3020
C.........ORBITER RECOVERED
 3036 IOR(LSC,N)=IOR(LSC,N)+1
      IPLR(LSC,N)=IPLR(LSC,N)+1
      GO TO 3020
 3034 CONTINUE
C.......B 24
      RN=RNDY5(DUMMY)
      IF(RN.GE.PPMO(II)) GO TO 3040
C....... PM OK
      RN=RNDY5(DUMMY)
      IF(RN.LT.PPMP(II)) GO TO 3046
C.......B4 DOES NOT PLACE PAYLOAD IN DESIRED ORBIT
      RN=RNDY5(DUMMY)
      IF(RN.LT.POR(II)) GO TO 3041
C...........ORBITER NOT RECOVERED
      IO(LSC,N)=IO(LSC,N)+1
      GO TO 3043
 3041 CONTINUE
C.......ORBITER RECOVERED
      IOR(LSC,N)=IOR(LSC,N)+1
 3043 IPL(LSC,N)=IPL(LSC,N)+1
      IPM(LSC,N)=IPM(LSC,N)+1
      GO TO 3020
 3040 CONTINUE
```

```
C.........PM DOES NOT CHECK OUT OK
      RN=RNDY5(DUMMY)
      IF(RN.LT.POR(II)) GO TO 3048
C.........ORBITER NOT RECOVERED
      IO(LSC,N)=IO(LSC,N)+1
      GO TO 3043
C
 3048 CONTINUE
C.........ORBITER RECOVERED
      IOR(LSC,N)=IOR(LSC,N)+1
      IPMR(LSC,N)=IPMR(LSC,N)+1
      GO TO 3020
C.......PM PLACES PAYLOAD IN DESIRED ORBIT
C.......B 26
C
 3046 CONTINUE
      RN=RNDY5(DUMMY)
      IF(RN.LT.PPS(LSC)) GO TO 3057
C.........PAYLOAD DOES NOT FUNCTION
      RN=RNDY5(DUMMY)
      K=0
      IF(RN.GE.PPLRR(II)) K=1
      RN=RNDY5(DUMMY)
      IF(RN.GE.PPMRP(II)) GO TO 3050
      RN=RNDY5(DUMMY)
      IF(RN.GE.POR(II)) GO TO 3051
C.....ORBITER RECOVERED
      IOR(LSC,N)=IOR(LSC,N)+1
      IF(K.GT.0) GO TO 3052
C....... PL WAS REACQUIRED
      IPLR(LSC,N)=IPLR(LSC,N)+1
      GOTO 3053
 3052 IPL(LSC,N)=IPL(LSC,N)+1
 3053 IPMP(LSC,N)=IPMP(LSC,N)+1
      GO TO 3020
 3050 CONTINUE
C.....PM DOES NOT RETURN TO ORBITER
      RN=RNDY5(DUMMY)
      IF(RN.LT.POR(II)) GO TO 3055
 3051 IO(LSC,N)=IO(LSC,N)+1
      GO TO 3043
 3055 IOR(LSC,N)=IOR(LSC,N)+1
      GO TO 3043
C
C.......PAYLOAD FUNCTIONS OK
C.......B 27
 3057 CONTINUE
      RN=RNDY5(DUMMY)
      IF(RN.GE.PPMRP(II)) GO TO 3060
C.......PM RETURNS TO ORBITER
      RN=RNDY5(DUMMY)
      IF(RN.GE.POR(II)) GO TO 3062
C......ORBITER RECOVERED
      IOR(LSC,N)=IOR(LSC,N)+1
      IPMR(LSC,N)=IPMR(LSC,N)+1
      IPL(LSC,N)=IPL(LSC,N)+1
 3035 CONTINUE
      NOS(LSC,N)=NOS(LSC,N)-1
C
C     END OF SUCCESSFUL LAUNCH SEQUENCE
```

```
C.........PM DOES NOT CHECK OUT OK
      RN=RNDY5(DUMMY)
      IF(RN.LT.POR(II)) GO TO 3048
C.........ORBITER NOT RECOVERED
      IO(LSC,N)=IO(LSC,N)+1
      GO TO 3043
C
 3048 CONTINUE
C..........ORBITER RECOVERED
      IOR(LSC,N)=IOR(LSC,N)+1
      IPMR(LSC,N)=IPMR(LSC,N)+1
      GO TO 3020
C.......PM PLACES PAYLOAD IN DESIRED ORBIT
C........P 26
C
 3046 CONTINUE
      RN=RNDY5(DUMMY)
      IF(RN.LT.PPS(LSC)) GO TO 3057
C.........PAYLOAD DOES NOT FUNCTION
      RN=RNDY5(DUMMY)
      K=0
      IF(RN.GE.PPLRP(II)) K=1
      RN=RNDY5(DUMMY)
      IF(RN.GE.PPMRP(II)) GO TO 3050
      RN=RNDY5(DUMMY)
      IF(RN.GE.POR(II)) GO TO 3051
C.....ORBITER RECOVERED
      IOR(LSC,N)=IOR(LSC,N)+1
      IF(K.EQ.0) GO TO 3052
C....... PL WAS REACQUIRED
      IPLR(LSC,N)=IPLR(LSC,N)+1
      GOTO 3053
 3052 IPL(LSC,N)=IPL(LSC,N)+1
 3053 IPMP(LSC,N)=IPMP(LSC,N)+1
      GO TO 3020
 3050 CONTINUE
C.....PM DOES NOT RETURN TO ORBITER
      RN=RNDY5(DUMMY)
      IF(RN.LT.POR(II)) GO TO 3055
 3051 IO(LSC,N)=IO(LSC,N)+1
      GO TO 3043
 3055 IOR(LSC,N)=IOR(LSC,N)+1
      GO TO 3043
C
C.......PAYLOAD FUNCTIONS OK
C.......P 27
 3057 CONTINUE
      RN=RNDY5(DUMMY)
      IF(RN.GE.PPMRP(II)) GO TO 3060
C.......PM RETURNS TO ORBITER
      RN=RNDY5(DUMMY)
      IF(RN.GE.POR(II)) GO TO 3062
C......ORBITER RECOVERED
      IOR(LSC,N)=IOR(LSC,N)+1
      IPMR(LSC,N)=IPMR(LSC,N)+1
      IPL(LSC,N)=IPL(LSC,N)+1
 3035 CONTINUE
      NOS(LSC,N)=NOS(LSC,N)-1
C
C     END OF SUCCESSFUL LAUNCH SEQUENCE
```

```
C
      GO TO 2079
 3060 CONTINUE
C.......PM DOES NOT RETURN TO ORBITER
      RN=RNDY5(DUMMY)
      IF(RN.LT.POF(II)) GO TO 3063
 3062 IO(LSC,N)=IO(LSC,N)+1
      GO TO 3064
 3063 ICR(LSC,N)=ICR(LSC,N)+1
 3064 IPM(LSC,N)=IPM(LSC,N)+1
      IPL(ISC,N)=IPL(LSC,N)+1
      GO TO 3035
C
C
C     END OF LAUNCH SEQUENCE
C
 2076 CONTINUE
C
C.....? 21
C
      FAC=FLOAT(N-III+1)**LCER
      DO 3070 LSC=1,MAXLSC
      C(1,LSC,N    )=ILA(LSC,N)*LCST(LSC,N)
      C(2,LSC,N    )=IPL(LSC,N)*SCCST(LSC,N)+IPLR(LSC,N)*UCM*.01*
     2  SCCST(LSC,N)*FAC
      C(3,LSC,N    )=C(1,LSC,N    )+C(2,LSC,N    )
      DO 3071 K=1,3
      IF(C(K,LSC,N    ).GT.AMX(K,LSC))AMX(K,LSC)=C(K,LSC,N    )
      IF(C(K,LSC,N    ).LT.AMN(K,LSC))AMN(K,LSC)=C(K,LSC,N    )
      SUMC(K,LSC,N)=SUMC(K,LSC,N)+C(K,LSC,N    )
      SUMSC(K,LSC,N)=SUMSC(K,LSC,N)+C(K,ISC,N    )**2
 3071 CONTINUE
 3070 CONTINUE
C
      DO 3090 K=1,3
      A=0.
      DO 3091 LSC=1,MAXLSC
 3091 A=A+    C(K,LSC,N)
      SUMCT(K,N)=SUMCT(K,N)+A
 3090 SUMSCT(K,N)=SUMSCT(K,N)+A**2
C
      DO 3072 K=1,3
      CT(K,N)=0.
      DO 3073 LSC=1,MAXLSC
      CT(K,N    )=CT(K,N    )+C(K,LSC,N    )
 3073 CONTINUE
      IF(CT(K,N    ).GT.AMXT(K))AMXT(K)=CT(K,N    )
      IF(CT(K,N    ).LT.AMT(K))AMT(K)=CT(K,N    )
 3072 CONTINUE
C
C
C.......?28
 3088 CONTINUE
      DO 4000 J=1,9
      II=0
      DO 4001 LSC=1,MAXLSC
 4001 II=II+IMONT(LSC,N,J)
      SUMJ(J,N)=SUMJ(J,N)+II
      SUMSJ(J,N)=SUMSJ(J,N)+II**2
      IF(II.GT.MAXI)II=MAXI
```

```
      IJ=II+1
      PE(IJ,J,N)=PE(IJ,J,N)+1
      IF(II.GT.MI)MI=II
 4000 CONTINUE
      DO 4009 LSC=1,MAXLSC
      II=ILA(LSC,N)
      SUMLA(LSC,N)=SUMLA(LSC,N)+II
      SUMSLA(LSC,N)=SUMSLA(LSC,N)+II**2
      IF(II.GT.MAXI)II=MAXI
      IJ=II+1
      PLA(IJ,LSC,N)=PLA(IJ,LSC,N)+1
      IF(II.GT.MLA(LSC,N))  MLA(LSC,N)=II
      II=IPL(LSC,N)
      SUMPL(LSC,N)=SUMPL(LSC,N)+II
      SUMSPL(LSC,N)=SUMSPL(LSC,N)+II**2
      IF(II.GT.MAXI)II=MAXI
      IJ=II+1
      PPL(IJ,LSC,N)=PPL(IJ,LSC,N)+1
      IF(II.GT.MPL(LSC,N))MPL(LSC,N)=II
 4009 CONTINUE
      ANPV=ANPV+CT(3,N)*PVF(N)
 9002 CONTINUE
C
C
C     END OF TIME LOOP
C
      SUMPV=SUMPV+ANPV
      IF(ANPV     .GT.PVX)PVX=ANPV
      IF(ANPV     .LT.PVN)PVN=ANPV
      SUMSPV=SUMSPV+ANPV**2
C
C*****OUTPUT ARRAYS TO DISK AND CLEAR STORAGE
C
      WRITE(2)C,CT,ANPV
 9001 CONTINUE
      REWIND 2
C
C
C
C     END OF MONTE CARLO
C
C
C
      DO 4010 K=1,3
      CSTIP(K)=(AMXT(K)-AMT(K))/NOINT
      DO 4010 LSC=1,MAXLSC
      CSTI(K,LSC)=(AMX(K,LSC)-AMN(K,LSC))/NCINT
 4010 CONTINUE
      PVI=(PVX-PVN)/NOINT
C
C     LOOP BACK OVER DATA STORED ON DISK
C
      DO 5000 NR=1,MAXR
      READ(2)C,CT,ANPV
C
C
      DO 5001 K=1,3
C
      IF(CSTIP(K).GT..001) GO TO 4032
      DO 4033 N=1,MAXN
```

```
 4033 PT(K,1,N)=MAXR
      GO TO 4037
 4032 DO 4035 N=1,MAXN
       L=(CT(K,N    )-AMT(K))/CSTIT(K)+.9999
      IF(L.EQ.0) L=1
      IF(L.GT.NOINT)L=NOINT
      PT(K,L,N)=PT(K,L,N)+1
 4035 CONTINUE
 4034 CONTINUE
 4037 CONTINUE
C
      DO 5002 LSC=1,MAXLSC
      CSTIK=CSTI(K,LSC)
      AMNK=AMN(K,LSC)
      IF(CSTIK.GT..0001) GO TO 5003
      DO 4023 N=1,MAXN
 4023 P(K,LSC,1,N)=MAXR
      GO TO 5002
 5003 DO 5004 N=1,MAXN
       L=(C(K,LSC,N    )-AMN(K,LSC))/CSTI(K,LSC)+.9999
      IF(L.EQ.0) L=1
      IF(L.GT.NOINT)L=NOINT
      P(K,LSC,L,N)=P(K,LSC,L,N)+1
 5004 CONTINUE
 5002 CONTINUE
 5001 CONTINUE
      IF(PVI.LT..001) GO TO 4049
       L=(AMEV     -PVN)/PVI+.999
      IF(L.EQ.0) L=1
      IF(L.GT.NOINT) L=NOINT
      PPV(L)=PPV(L)+1
      GO TO 4042
 4049 CONTINUE
      PPV(1)=MAXR
 4042 CONTINUE
 5000 CONTINUE
C
C
C.....# 33
C
C
      AMAXR=MAXR
      IF(DETC.NE.1) GO TO 4050
      DO 4051 K=1,3
      DO 4051 LSC=1,MAXLSC
      DO 4051 N=ITL,MAXN
      MCST(K,LSC,N)=SUMC(K,LSC,N)/AMAXR
      STDCST(K,LSC,N)=DEV(SUMSC(K,LSC,N),MCST(K,LSC,N))
 4051 CONTINUE
 4050 CONTINUE
      DO 4060 N=ITL,MAXN
      DO 4052 J=1,3
      ME(J,N)=SUMJ(J,N)/AMAXR
      STDE(J,N)=DEV(SUMSJ(J,N),ME(J,N))
 4052 CONTINUE
      DO 4053 K=1,3
      MT(K,N)=SUMCT(K,N)/AMAXR
      STDT(K,N)=DEV(SUMSCT(K,N),MT(K,N))
 4053 CONTINUE
      DO 4054 LSC=1,MAXLSC
```

```
      MLA(LSC,N)=SUMLA(LSC,N)/AMAXR
      STDLA(LSC,N)=DEV(SUMSLA(LSC,N),MLA(LSC,N))
      MPL(LSC,N)=SUMPL(LSC,N)/AMAXR
      STDPL(LSC,N)=DEV(SUMSPL(LSC,N),MPL(LSC,N))
 4054 CONTINUE
 4060 CONTINUE
      MPV=SUMPV/AMAXR
      STDPV=DEV(SUMSPV,MPV)
C..................
C***********PRINT REPORTS
C................
      CALL OUTPUT
      STOP
      END
      SUBROUTINE OUTPUT
      REAL MPV
      COMMON/OUTS/MI,PE,MAXR,ME,STDE,AMT,NOINT,CSTIT,P,MT,STDT,MCST,
     1 STDCST,PLA,MAXN,MLA,STDLA,PVN,PVI,PPV,MPV,STDPV,ITL,DETC
     2 ,PT,PPL,MPL,STDPL,AMN,CSTI,MAXLSC,DP
      INTEGER DETC
      DIMENSION LABEL(3,8),LABIL(3,8)
      REAL AMN(3,5),CSTI(3,5)
      REAL PE(25,9,25),ME(9,25),STDE(9,25),AMT(3),CSTIT(3),P(3,5,40,25)
      REAL MT(3,25),STDT(3,25),MCST(3,5,25),STDCST(3,5,25),PLA(25,5,25)
      REAL MPL(5,25),STDPL(5,25),PPV(40)
      REAL MLA(5,25),STDLA(5,25),PT(3,40,25),PPL(25,5,25)
      AXR=MAXR
      MI1=MI+1
      DO 511 LSC=1,MAXLSC
      DO 511 N=1,MAXN
      DO 511 M=1,MI
  611 PPL(M,LSC,N)=PPL(M,LSC,N)/ AXR
  511 PLA(M,LSC,N)=PLA(M,LSC,N)/ AXR
      DO 1000 K=1,3
      READ(5,1001) (LABEL(K,I),I=1,8)
      READ(5,1001) (LABIL(K,I),I=1,8)
 1001 FORMAT(8A4)
      DO 444 N=1,MAXN
      DO 444 NO=1,NOINT
      DO 502 LSC=1,MAXLSC
  502 P(K,LSC,NO,N)=P(K,LSC,NO,N)/ AXR
  444 PT(K,NO,N)=PT(K,NO,N)/ AXR
 1000 CONTINUE
      DO 2 I=1,MI1
      DO 2 J=1,9
      DO 2 N=ITL,MAXN
    2 PE(I,J,N)=PE(I,J,N)/ AXR
C
      DO 1 N=ITL,MAXN
      WRITE(6,999)
  999 FORMAT(1H1)
      WRITE(6,700)
  700 FORMAT(20X,'ESTABLISHMENT AND MAINTENANCE')
      WRITE(6,701)
  701 FORMAT(15X,'OF A SYSTEM OF EARTH ORBITING SPACECRAFT')
      WRITE(6,1002)
 1002 FORMAT(/)
      WRITE(6,702) N
      WRITE(6,1002)
  702 FORMAT(60X,'YEAR:',1X,1I2)
```

```
      WRITE(6,703)
  703 FORMAT(20X,'PROBABILITY OF INDICATED QUANTITY')
      WRITE(6,719)
C
      DO 3 II=1,MI1
      I=MI-II+1
      J=I+1
    3 WRITE(6,704)I,(EF(J,K,N),K=1,9)
  704 FORMAT(1X,1I3,9X,9F11.3)
C
      WRITE(6,705)
  705 FORMAT(19X,'LAUNCH',05X,'ADDIT.',05X,'ADDIT.',05X,'ADDIT.',05X,
     1    'SPACECRAFT',01X,'BOOSTERS',03X,'ORBITERS',03X,'PMS',08X,'SPACE
     2CRAFT')
      WRITE(6,706)
  706 FORMAT(19X,'ATTEMPTS',03X,'BOOSTERS',03X,'ORBITERS',03X,'PMS',08X,
     $   'REQUIRED',03X,'REFURB.',04X,'REFURB.',04X,'REFURB.',04X,'REFURB
     @.')
      WRITE(6,707)
  707 FORMAT(30X,'REQUIRED',03X,'REQUIRED',03X,'REQUIRED')
      WRITE(6,708)
  708 FORMAT(01X,'EXPECTED')
      WRITE(6,709) (ME(I,N),I=1,9)
  709 FORMAT(01X,'NUMBER',5X,9F11.2)
    1 WRITE(6,710) (STDE(I,N),I=1,9)
  710 FORMAT(01X,'STD. DEV.',02X,9F11.2)
C
C
C
      DO 4 K=1,3
      CK=CSTIT(K)
      AMTK=AMT(K)
      WRITE(6,999)
      WRITE(6,700)
      WRITE(6,701)
      WRITE(6,1002)
      WRITE(6,711) (LABEL(K,I),I=1,8)
      WRITE(6,1002)
  711 FORMAT(20X,'PROBABILITY OF INDICATED ',8A4)
      WRITE(6,712)
  712 FORMAT(05X,'COST'/05X,'RANGE'/,04X,'(MILLIONS'/,04X,'OF DOLLARS)')
      DO 44 NO=1,NOINT
      J=NOINT-NO+1
      I=J-1
      A=AMTK+I*CK
      B=AMTK+J*CK
   44 WRITE(6,713) A,B,(PT(K,J,N),N=1,MAXN)
      WRITE(6,1002)
      WRITE(6,921) (N,N=1,MAXN)
  921 FORMAT(02X,'YEAR',13X,10I8)
      WRITE(6,1002)
  713 FORMAT(1X,1F7.2,'---',1F7.2,6X,10F8.3)
      WRITE(6,714) (MT   (K,N),N=1,MAXN)
  714 FORMAT(05X,'EXPECTED COSTS',03X, 10F8.1)
      WRITE(6,715) (STDT(K,N),N=1,MAXN)
  715 FORMAT(05X,'STD. DEV.',8X,10F8.1)
    4 CONTINUE
C
C
C
```

```
      IF(DETC.EQ.0) GO TO 5
      DO 500 K=1,3
      DO 500 LSC=1,MAXLSC
      CK=CSTI(K,LSC)
      AK=AMN(K,LSC)
      WRITE(6,999)
      WRITE(6,700)
      WRITE(6,701)
      WRITE(6,1002)
      WRITE(6,911) (LABEL(K,I),I=1,8),LSC
  911 FORMAT(20X,'PROBABILITY OF INDICATED ',8A4,1I2,')')
      WRITE(6,1002)
      WRITE(6,712)
      DO 501 NO=1,NOINT
      J=NOINT-NO+1
      I=J-1
      A=AK+I*CK
      B=AK+J*CK
  501 WRITE(6,713) A,B,(P( K,LSC,J,N),N=1,MAXN)
      WRITE(6,1002)
      WRITE(6,921) (N,N=1,MAXN)
      WRITE(6,1002)
      WRITE(6,714) (MCST(K,LSC,N),N=1,MAXN)
      WRITE(6,715) (STDCST(K,LSC,N),N=1,MAXN)
  500 CONTINUE
    5 CONTINUE
C
C
C
      DO 510 LSC=1,MAXLSC
      WRITE(6,999)
      WRITE(6,700)
      WRITE(6,701)
      WRITE(6,1002)
      WRITE(6,716) LSC
      WRITE(6,1002)
  716 FORMAT(40X,'SPACECRAFT TYPE :',1I3)
      WRITE(6,718)
  718 FORMAT(10X,'PROBABILITY OF INDICATED LAUNCH ATTEMPTS')
      WRITE(6,1002)
      WRITE(6,719)
  719 FORMAT(02X,'QUANTITY')
      DO 512 M=1,MI1
      I=MI-M+1
      J=I+1
      WRITE(6,720) I,(PLA(J,LSC,N),N=1,MAXN)
  720 FORMAT(03X,1I2,10X,10F6.3)
  512 CONTINUE
      WRITE(6,1002)
      WRITE(6,721) (N,N=1,MAXN)
  721 FORMAT(02X,'YEAR',06X,10I6)
      WRITE(6,1002)
      WRITE(6,722) (MLA(LSC,N),N=1,MAXN)
  722 FORMAT(3X,'EXPECTED'/3X,'NUMBER',5X,10F6.2           )
      WRITE(6,723) (STDLA(LSC,N),N=1,MAXN)
  723 FORMAT(3X,'STD. DEV.',2X,10F6.2)
  510 CONTINUE
C
C
C
```

```
C
C
      DO 610 LSC=1,MAXLSC
      WRITE(6,999)
      WRITE(6,700)
      WRITE(6,701)
      WRITE(6,1002)
      WRITE(6,716) LSC
      WRITE(6,1002)
      WRITE(6,725)
  725 FORMAT(10X,'PROBABILITY OF INDICATED SPACECRAFT REQUIRED')
      WRITE(6,1002)
      WRITE(6,719)
      DO 612 M=1,MI1
      I=MI-M+1
      J=I+1
      WRITE(6,720) I,(PPL(J,LSC,N),N=1,MAXN)
  612 CONTINUE
      WRITE(6,1002)
      WRITE(6,721) (N,N=1,MAXN)
      WRITE(6,1002)
      WRITE(6,722) (MPL(LSC,N),N=1,MAXN)
      WRITE(6,723) (STDPL(LSC,N),N=1,MAXN)
  610 CONTINUE
C
C
C
C
      DO 800 NO=1,NOINT
  800 PPV(NO)=PPV(NO)/ AKR
      WRITE(6,999)
      WRITE(6,700)
      WRITE(6,701)
      WRITE(6,1002)
      WRITE(6,726)
  726 FORMAT(10X,'PRESENT VALUE',13X,'PROBABILITY OF INDICATED')
      WRITE(6,727)
  727 FORMAT(10X,'(MILLIONS OF DOLLARS)',05X,'PRESENT VALUE OF COST')
      WRITE(6,728) DR
  728 FORMAT(36X,'(DISCOUNT RATE=',1F4.1,')')
      WRITE(6,1002)
      DO 729 NO=1,NOINT
      J=NOINT-NO
      I=J+1
      A=PVN+J*PVI
      B=PVN+I*PVI
      WRITE(6,789) A,B,PPV(I)
  729 CONTINUE
      WRITE(6,1002)
  789 FORMAT(10X,1F8.2,'--',1F8.2,16X, 1F5.3)
      WRITE(6,790) MPV
  790 FORMAT(10X,'EXPECTED PV',19X, 1F8.2)
      WRITE(6,791) STDPV
  791 FORMAT(10X,'STD.DEV.',22X,1F8.2)
      RETURN
      END
      SUBROUTINE ALIST1(SUMPL,SUMSPL,P,PPL,PT,PPV,ANPV,SUMPV,SUMSPV,
     1 MAXLS,MAXN,MAXNB,MAXLSC        ,PFS         ,PFB,SUMLA,SUMSLA,MLA,
     2 MPL,SUMC,SUMSC,PLA,SUMJ,SUMSJ,PE)
      REAL              SUMPL(5,25),SUMSPL(5,25),P(3,5,40,25),PPL(25,5,25
```

```
     1),PT(3,40,25),PPV(40)
      REAL  SUMJ(9,25),SUMSJ(9,25),PE(25,9,25)
      REAL              PFS(10,25),             PFB(5,25),SUMLA(5,25)
      REAL  SUMSLA(5,25),SUMC(3,5,25),SUMSC(3,5,25),PLA(25,5,25),MLA(5,25
     3  ),MPL(5,25)
C
      DO 800 LS=1,10
      DO 800 N=1,25
  800 PFS(LS,N)=0.0
C
      DO 801 NB=1,5
      DO 801 N=1,25
  801 PFB(NB,N)=0.
C
      DO 802 N=1,25
      DO 803 LSC=1,5
      SUMPL(LSC,N)=0
      SUMSPL(LSC,N)=0
      SUMLA(LSC,N)=0
      SUMSLA(LSC,N)=0
      MLA(LSC,N)=0
      MPL(LSC,N)=0
C
      DO 804 K=1,3
      DO 2013 L=1,40
 2016 PPV(L)=0
 2015 PT(K,L,N)=0
 2013 P(K,LSC,L,N)=0
      SUMC(K,LSC,N)=0.
  804 SUMSC(K,LSC,N)=0
C
      DO 805 II=1,25
 2014 PPL(II,LSC,N)=0
  805 PLA(II,LSC,N)=0
C
  803 CONTINUE
C
      DO 806 J=1,9
      SUMJ(J,N)=0.
      SUMSJ(J,N)=0.
      DO 806 II=1,25
  806 PE(II,J,N)=0
  802 CONTINUE
C
      ANPV=0.
      SUMPV=0.
      SUMSPV=0.
      RETURN
      END
      SUBROUTINE ALIST2(COST,
     1 MAXLSC,MAXLS,MAXR,IX,SCCST,LCST,ILA,IB,IBR,IPL,IO,IOR,IPM,IPLR,
     2 IPMR,                   NOOP,    NFAIL,IS,ISS)
      REAL  LCST(5,25),COST(5,25)
      INTEGER IX(5),ILA(5,25),IB(5,25),IBR(5,25),IPL(5,25),IO(5,25),
     1IOR(5,25),IPM(5,25),IPLR(5,25),IPMR(5,25),NOOP(10,25),NFAIL(5,20),
     2  IS(5,20),ISS(10,5,20)
      REAL  SCCST(5,25)
C
      DO 420 LSC=1,5
  420 IX(LSC)=1
```

```
C
      DO 1099 N=1,25
C
      DO 2008 LSC=1,5
      COZT(LSC,N)=1.E10
      SCCST(LSC,N)=1.E10
      LCST(LSC,N)=1.E10
      ILA(LSC,N)=0
      IB(LSC,N)=0
      IBP(LSC,N)=0
      IPL(LSC,N)=0
      IO(LSC,N)=0
      IOR(LSC,N)=0
      IPM(LSC,N)=0
      IPLR(LSC,N)=0
      IPMR(LSC,N)=0
 2008 CONTINUE
C
      DO 2012 LS=1,10
 2012 NOOP(LS,N)=0
C
 1099 CONTINUE
      DO 2010 M=1,20
      DO 2010 LSC=1,5
      NFAIL(LSC,M)=0
      IS(LSC,M)=0
      DO 2011 LS=1,10
 2011 ISS(LS,LSC,M)=0
 2010 CONTINUE
      RETURN
      END
      SUBROUTINE DFLTIN( PPMP,
     1NOSEN,ISMIX,IBMIX,AMTBF,STANDL,AMEANL,AMTBS,STANDS,AMEANS,AMAXC,
     2  AMINC,IPT,CALC,AMAXB,AMINB,IPTB,CALB,AMAXM,AMINM,IPTM,CALM,
     3  AMAXLC,AMINLC,IPTLC,CALLC,LNCHS,ORBCAP,PPS,PBS,PBRS,PBRF,PCS,
     3  PCROF,PORBF,POR,PPMO,PPMRP,PPLRR,MAXM,NN,DR,DETC)
      INTEGER NOSEN(10,25),ISMIX(10,5),IBMIX(5),IPT(10),IPTB(5),
     1  IPTLC(5,10),LNCHS(5,25),MAXM(5)
      REAL CALC(10)
       REAL PPMP(10)
      REAL AMTBF(10,5),STANDL(10,5),AMEANL(10,5),AMTBS(10),STANDS(10)
      REAL AMEANS(10),AMAXC(10),AMINC(10),AMAXB(5),AMINB(5),CALB(5)
      REAL AMAXLC(5,10),AMINLC(5,10),CALLC(5,10)            ,PPS(5),PBS(10
     1 ),PBRS(10),PBRF(10),POS(10),POROF(10),PORBF(10),POR(10),PPMO(10)
      INTEGER ORBCAP(5)
      REAL PPMRP(10),PPLRR(10)
      DO 700 LS=1,10
      DO 701 N=1,25
  701 NOSEN(LS,N)=0
      DO 700 LSC=1,5
  700 ISMIX(LS,LSC)=0
      DO 702 LSC=1,5
  702 IBMIX(LSC)=1
      DO 703 LB=1,10
      DO 703 NB=1,5
      AMTBF(LB,NB)=5.
      STANDL(LB,NB)=.5
  703 AMEANL(LB,NB)=5.0
      DO 704 LS=1,10
      AMTBS(LS)=5.0
```

```
      STANDS(LS)=5.0
      AMEANS(LS)=5.0
      AMAXC(LS)=0
      AMINC(LS)=0
      IPT(LS)=16
 704  CALC(LS)=90.
      DO 705 NB=1,5
      AMAXB(NB)=0.
      AMINB(NB)=0.
      IPTB(NB)=16
      CALB(NB)=90.
 705  CONTINUE
      AMAXM=0.
      AMINM=0.
      IPTM=16
      CALR=90.
      DO 707 LSC=1,5
      DO 707 IE=1,10
      AMAXLC(LSC,IE)=0.
      AMINLC(LSC,IE)=0.
      IPTLC(LSC,IE)=16
      CALLC(LSC,IE)=90.
 707  CONTINUE
      DO 708 LSC=1,5
      DO 708 N=1,25
 708  LNCHS(LSC,N)=1
      DO 710 LSC=1,5
      ORBCAP(LSC)=0
 710  PPS(LSC)=1.00
      DO 711 IE=1,10
      PBS(IE)=1.
      PBRS'(IE)=1.
      PBRF(IE)=1.
      POS(IE)=1.
      POROF(IE)=1.
      PORBF(IE)=1.
      POR(IE)=1.
      PPMO(IE)=1.
      PPMP(IE)=1.
      PPMRP(IE)=1.
 711  PPLRR(IE)=1.
      DO 712 LSC=1,5
 712  MAXN(LSC)=10
      NN=5
      DR=10.
      DETC=0
      RETURN
      END
      SUBROUTINE RELTAB(MAXLB,
     1 MAXNB,MAXN,PFB,RELB,AMTBF,STANDL,AMEANL,MAXLS,PFS,RELS,AMTBS,
     2  STANDS,AMEANS)
      REAL  PFB(5,25),RELB(5,25),AMTBF(10,5),STANDL(10,5),AMEANL(10,5)
      REAL  PFS(10,25),RELS(10,25),AMTBS(10),STANDS(10),AMEANS(10)
      DATA  PI/3.1415926535/
      R(X,Y,Z,W)=EXP(-X/Y)*ERFC((X-Z)/(ROT*W))/2.
      ROT= SQRT(2.0)
      DO 1001 N=1,MAXN
      F=N
      DO 1002 NB=1,MAXNB
      A=1.
```

```
      DO 1003 LB=1,MAXLB
      REL=R(F,AMTBF(LB,NB),AMEANL(LB,NB),STANDL(LB,NB))
 1003 A=A*REL
      RELB(NB,N)=A
      PFB(NB,N)=1.-RELB(NB,N)
      IF(N.EQ.1) GO TO 1002
      PFB(NB,N)=1.
      IF(RELB(NB,N-1).GT.1.E-50) PFB(NB,N)=1.-RELB(NB,N)/RELB(NB,N-1)
 1002 CONTINUE
C
C
      DO 1011 LS=1,MAXLS
      RELS(LS,N)=R(F,AMTBS(LS),AMEANS(LS),STANDS(LS))
      PFS(LS,N)=1.-RELS(LS,N)
      IF(N.EQ.1) GO TO 1011
      PFS(LS,N)=1.
      IF(RELS(LS,N-1) .GT.1.E-50) PFS(LS,N)=1.-RELS(LS,N)/RELS(LS,N-1)
 1011 CONTINUE
 1001 CONTINUE
      RETURN
      END
      SUBROUTINE NOSAT(MATRIX,INDEXR,INDEXC,MMAT,NMAT)
C
      INTEGER SAT,DEM
      REAL*8 MATRIX(MMAT,NMAT)
      INTEGER DEBUG
      INTEGER*2 INDEXC(NMAT),INDEXR(MMAT)
      COMMON/LINEAR/COST(5,25),NSEN,NSAT,NYEAR,NTIME,
     -   SAT(10,5),DEM(10,25)
      COMMON/LAUNCH/NUMSAT(5),TCOST
      COMMON/PPNI/DEBUG
C
C        COMPUTES THE  NUMBER OF SATELLITES OF TYPE J TO LAUNCH
C        IN THE GIVEN INPUT YEAR
C
C     INPUT---
C        COST:: TOTAL COST OF S/C OF TYPE I IN YEAR J
C        NSEN:: NUMBER OF SENSOR TYPES
C        NSAT:: NUMBER OF S/C TYPES
C        NYEAR:: NUMBER OF YEARS TO LOOK AHEAD
C        NTIME:: INDEX FOR THE CURRENT YEAR
C        SAT:: NUMBER OF SENSOR OF TYPE I ON S/C OF TYPE J
C        DEM:: DEMAND FOR SENSOR OF TYPE I IN YEAR J
C     OUTPUT---
C        NUMSAT:: NUMBER OF S/C OF TYPE I TO LAUNCH FOR THE CURRENT YEAR
C        TCOST::COST OF LAUNCHING THE TOTAL NUMBER OF S/C
C
      NVAR=NMAT-1
      NTIMER=NTIME-1
C
C        ZAP MATRIX
C
      DO1IZAP=1,MMAT
      DO1JZAP=1,NMAT
 1    MATRIX(IZAP,JZAP)=0.0D0
C
C        INITIALIZE INDEX FOR ROW AND COLUMN VARIABLES
C
      DO2JCOL=1,NMAT
 2    INDEXC(JCOL)=JCOL
```

```
      DO3IROW=1,MMAT
      NVAR=NVAR+1
3     INDEXR(IROW)=NVAR
C
C        GENERATE SIMPLEX MATRIX
C
      DO100IYEAR=1,NYEAR
      NTIMER=NTIMER+1
      IYM=IYEAR-1
      JCOL1=IYM*NSAT
      NCOL=JCOL1
      JCOL2=IYM*NSEN+NSAT*NYEAR
      JCOL3=JCOL2-NSEN
      IROW1=IYM*NSEN
C
      DO90ISEN=1,NSEN
      IROW1=IROW1+1
      JCOL1=JCOL1+1
      JCOL2=JCOL2+1
C
C        POSITIVE IDENTITY MATRIX
C
      MATRIX(IROW1,JCOL2)=1.0D0
C
      IF(IYM)20,20,10
C
C        NEGATIVE IDENTITY MATRIX
C
10    JCOL3=JCOL3+1
      MATRIX(IROW1,JCOL3)=-1.0D0
C
C        DEMAND FOR SENSORS
C
20    MATRIX(IROW1,NMAT)=-DEM(ISEN,NTIMER)
C
      JCOL4=NCOL
      DO80ISC=1,NSAT
      JCOL4=JCOL4+1
C
C        S/C--SENSOR RELATIONSHIP
C
      MATRIX(IROW1,JCOL4)=-SAT(ISEN,ISC)
C
      IF(ISEN-1)70,70,80
C
C        COST FOR S/C
C
70    MATRIX(MMAT,JCOL4)=-COST(ISC,NTIMER)
C
80    CONTINUE
90    CONTINUE
100   CONTINUE
C
C
C        RUN SIMPLEX ALGORITHM
C
C
  200 CONTINUE
      CALL PVSEL8(MATRIX,MMAT,NMAT,IROW,JCOL)
      IF(IROW.EQ.0.OR.JCOL.EQ.0)GOTO300
```

```
      CALL PIVOT8(MATRIX,MMAT,NMAT,INDEXR,INDEXC,IROW,JCOL)
      GOTO 200
C
C        DETERMINE THE NUMBER OF S/C TO LAUNCH OF EACH TYPE
C        DETERMINE THE TOTAL LAUNCH COSTS
C
300   DO310IZAP=1,NSAT
310   NUMSAT(IZAP)=0
      MMM=MMAT-1
      TCOST=0.0
      DO330ICHK=1,MMM
      IND=INDEXR(ICHK)
      IF(IND.GT.NSAT)GOTO330
      NUMSAT(IND)=MATRIX(ICHK,NMAT)+.999D0
      TCOST=TCOST+NUMSAT(IND)*COST(IND,NTIME)
330   CONTINUE
C
      RETURN
C
  800 DO 801 I=1,5
  801 NUMSAT(I)=1
      RETURN
      END
PVSEL8   CSECT
         USING   *,15
         STM     14,12,12(13)
*
*
*     SUBROUTINE PVSEL8 (MAT,M,N,IROW,JCOL)
*     MAT IS AN M BY N REAL DOUBLE-PRECISION ARRAY.
*  ORIGINALLY WRITTEN IN FORTRAN BY PHILIP ABRAM.
*  PRESENT VERSION 5 MAY 1975 BY R. BECKSTROTH
*
*
*  REGISTERS:
*
*  2  BASE FOR (M,JMIN) (M-1)*8
*  3  BASE FOR (IMIN,N) (N-1)*M*8
*  4  MAT
*  5  MINROW, THEN BASE FOR (IROW,JMIN),'IROW'
*  6  MINCOL, BASE FOR (IMIN,JCOL)
*  7  LOOP INDEX, 'JCOL'
*  8  ROW INCREMENT (=8)
*  9  MMO LIMIT (=(M-2)*8)
*  10 COLUMN INCREMENT (M*8)
*  11 NMO LIMIT ((M*N-M)*8 = M(N-2)*8)
*
*
*  FLOATING-POINT REGISTERS:
*
*  0  MIN
*  2  MAX
*  4  -1.D-30, THEN 1.D-30
*  6  VALUE
*
*
         L       2,4(0,1)          ADDR (M)
         L       3,8(0,1)          ADDR (N)
         L       4,0(0,1)          ADDR (MAT)
         L       2,0(0,2)          M
```

```
         L     3,0(0,3)         N
         BCTR  3,0              N-1
         SR    7,7              INDEX
         LR    11,3             N-1
         MR    10,2             M(N-1)
         L     8,=F'8'
         LR    3,11             (N-1)*M
         SR    11,2             (N-1)*M-M = (N-2)*M
         SLL   11,3             M*(N-2)*8
         LR    10,2             M
         SR    5,5              MINROW
         SLL   10,3             M*8
         BCTR  2,0              M-1
         SR    6,6              MINCOL
         LR    9,2              M-1
         SLL   2,3              (M-1)*8
         SLL   3,3              (N-1)*8*M
         AR    2,4              BASE
         AR    3,4              BASE
         BCTR  9,0              M-2
         LD    0,=D'9.999E50'   MIN
         SLL   9,3              (M-2)*8
*
*
         CNOP  0,8
DO10     CD    0,0(7,3)         MIN VS. MAT (IMIN,N)
         BL    END10
         LR    5,7
         LD    0,0(7,3)
END10    BXLE  7,8,DO10
*
*
         CD    0,=D'0'          IF (MIN.GE.0)
         BNL   MAX              GO TO MAX; ELSE DO 20 LOOP & RETURN.
         L     12,12(0,1)       ADD (IROW)
         LR    7,5              CONVERT MINROW TO FORTRAN FORM.
         SRL   7,3
         LA    7,1(0,7)
         ST    7,0(0,12)        IROW
         LD    4,=D'-1.E-30'
         LD    0,=D'9.999E50'   MIN
         SR    6,6              INDEX
         SR    7,7              'JCOL'
         AR    5,4              BASE FOR MAT (IROW,JMIN)
         SR    7,10             -(M*8) = FORTRAN ZERO
*
*
         CNOP  0,8
DO20     CD    4,0(6,5)         -1.D-30 VS. MAT (IROW,JMIN)
         BL    END20
         LD    6,0(6,2)         MAT (M,JMIN)
         DD    6,0(6,5)         /MAT (IROW,JMIN)
         CDR   6,0
         BNL   END20
         LR    7,6              'JCOL' = JMIN.  STORED BELOW
         LDR   0,6              MIN = VALUE
END20    BXLE  6,10,DO20
         L     12,16(0,1)       ADDR (JCOL)
         AR    7,10             CONVERT 'JCOL' TO FORTRAN FORM.
         SR    6,6
```

```
         DR    6,10                JCOL/(M*8)
         ST    7,0(0,12)           JCOL
*
         LM    14,12,12(13)
         BR    14                  RETURN
*
*
MAX      LD    2,=D'-9.999E50'
         SR    7,7                 MINCOL
         SR    6,6                 INDEX
*
*
         CNOP  0,8
DO110    CD    2,0(6,2)            MAX VS. MAT (M,JMIN)
         BH    END110
         LR    7,6                 MINCOL
         LD    2,0(6,2)            MAX=MAT(M,JMIN)
END110   BXLE  6,10,DO110
*
*
         CD    2,=D'0'             MAX VS. 0
         BH    MORE                GREATER: GO ON
         SR    0,0                 ELSE IROW,JCOL=0 AND RETURN
         L     2,12(0,1)           ADDR (IROW)
         L     3,16(0,1)           ADDR (JCOL)
         ST    0,0(0,2)            IROW=0
         ST    0,0(0,3)            JCOL=0
         LM    14,12,12(13)
         BR    14
*
*
MORE     ST    7,MINCOL
         AR    7,10                CONVERT MINCOL TO FORTRAN FORM.
         SR    6,6
         DR    6,10
         L     12,16(0,1)          ADDR (JCOL)
         LD    0,=D'9.999E50'      MIN
         LD    4,=D'1.E-30'
         ST    7,0(0,12)           JCOL
         SR    7,7                 INDEX
         SR    5,5                 'IROW'
         L     6,MINCOL
         SR    5,8                 -8 = FORTRAN ZERO
         AR    6,4                 MINCOL + ADDR (MAT) BASE 120 LOOP
DO120    CD    4,0(7,6)            1.E-30 VS. MAT (IMIN,JCOL)
         BH    END120
         LD    6,0(7,3)            MAT (IMIN,N)
         DD    6,0(7,6)            / MAT (IMIN,JCOL)
         CDR   6,0                 VALUE VS. MIN
         BNL   END120
         LR    5,7                 'IROW'
         LDR   0,6                 MIN=VALUE
END120   BXLE  7,8,DO120
         SRL   5,3                 CONVERT IROW TO FORTRAN FORM
         LA    5,1(0,5)
         L     12,12(0,1)          ADDR (IROW)
         ST    5,0(0,12)           IROW
         LM    14,12,12(13)
         BR    14
*
```

```
*
MINCOL   DS     1F
         END
PIVOT8   CSECT
         USING  *,15
         STM    14,12,12(13)
*
*
*        SUBROUTINE PIVOT8 (MATRIX,M,N,INDEXR,INDEXC,IROW,JCOL)
*        MATRIX IS AN M BY N REAL DOUBLE-PRECISION ARRAY.
*        INDEXR (M) AND INDEXC (N) ARE HALFWORD INTEGER ARRAYS.
*    ORIGINALLY WRITTEN IN FORTRAN BY PHILIP ABRAM 4/4/75
*    PRESENT VERSION BY R. HECKSTROTH 4/31/75
*    REGISTERS DURING EXECUTION OF LOOPS:
*        1  INDEX OF IROW,JPIV
*        2  HIGH INNER LOOP INCREMENT
*        3  HIGH INNER LOOP LIMIT
*        4  ADDRESS OF MATRIX
*        5  INDEX REGISTER FOR IPIV,JCOL
*        6  INDEX REGISTER FOR IPIV,JPIV
*        7  OUTER LOOP INDEX
*        8  OUTER LOOP INCREMENT
*        9  OUTER LOOP LIMIT (CHANGED BETWEEN TWO LOOPS)
*        10 INNER LOOP INCREMENT
*        11 INNER LOOP LOW LIMIT
*        12 INNER LOOP INDEX
*        13-15 LINKAGE
*
*    FLOATING POINT REGISTERS:
*        0  RECIP
*        6  MRJR (MRJ*RECIP)
*
*
*
         L      12,20(0,1)         ADDR (IROW)
         L      12,0(0,12)          IROW
         BCTR   12,0               IROW-1
         LR     2,12
         SLL    2,1                (IROW-1)*2
         L      3,12(0,1)          ADDR (INDEXR)
         LH     0,0(2,3)           ITMP=INDEXR(IROW)
         L      4,24(0,1)          ADDR (JCOL)
         L      4,0(0,4)           JCOL
         BCTR   4,0                JCOL-1
         LR     9,4                JCOL-1
         SLL    4,1                (JCOL-1)*2
         L      5,16(0,1)          ADDR (INDEXC)
         LH     6,0(4,5)           INDEXC (JCOL)
         STH    6,0(2,3)           INDEXR (IROW)=INDEXC (JCOL)
         STH    0,0(4,5)           INDEXC (JCOL)=ITMP
         L      2,4(0,1)           ADDR (M)
         L      2,0(0,2)           M
         LR     7,2                M
         SLL    7,3                M*8   OUTER LOOP INCREMENT
         LR     5,9                JCOL-1
         MR     4,7                (JCOL-1)*M*8
         ST     5,JCOLBASE
         L      3,8(0,1)           ADDR (N)
         L      3,0(0,3)           N
         ST     3,N
```

```
         LR       5,2                M
         MR       4,3                M*N
         SR       5,2                M*N-M
         SLL      5,3                (M*N-M)*8  SECOND OUTER LOOP LIMIT
         ST       5,NEWLIMIT
         BCTR     9,0                JCOL - 2
         MR       8,2                (JCOL-2) * M
         LR       3,2                M
         SLL      9,3                (JCOL-2)*M*8  FIRST OUTER LOOP LIMIT
         LR       8,7                OUTER LOOP INCREMENT
         SR       7,7                OUTER LOOP INDEX
         LR       11,12              IROW-1
         LR       2,12
         SLL      2,3                (IRWO-1)*8
         ST       2,IROWBASE         (USED AT END IN PIVOT ASSIGNMENT.)
         A        2,JCOLBASE         IROW,JCOL INDEX
         BCTR     11,0               IROW-2
         SLL      11,3               (IROW-2)*8  LOW INNER LOOP LIMIT
         L        10,=F'8'           INNER LOOP INCREMENT
         SLL      3,3                M*8
         SR       3,10               M*8-8 = (M-1)*,  HIGH INNER LOOP LIM
         L        4,0(0,1)           ADDR (MATRIX)
         LD       0,=D'1.'
         DD       0,0(2,4)           1./MATRIX(IROW,JCOL)     RECIP
         L        1,IROWBASE         IROW,JPIV INDEX REGISTER
         L        2,=F'8'            INNER LOOP INCREMENT
         SR       6,6                IPIV,JPIV REGISTER
         C        6,JCOLBASE         IS (JCOL-1) = 0?  THEN IT'S AN EDGE
         BE       EDGE0
*
*
         CNOP     0,8
OUTER1   L        5,JCOLBASE
         SR       12,12              INNER LOOP INDEX REGISTER
         LD       6,0(1,4)           MRJ = MATRIX (IROW,JPIV)
         CD       6,=D'1.E-30'
         BH       MRJUNIOR           SIGNIFICANTLY POSITIVE
         CD       6,=D'-1.E-30'
         BNL      NOEFFECT           NOT SIGNIFICANTLY NEGATIVE.
MRJUNIOR MDR      6,0                MRJ * RECIP
         C        12,IROWBASE         IS (IROW-1)=0?   THEN EDGE
         BE       EDGE1
*
*
         CNOP     0,8
INNER1   LD       2,0(6,4)           MATRIX (IPIV,JPIV)
         LD       4,0(5,4)           MATRIX (IPIV,JCOL)
         MDR      4,6                *MRJR
         SDR      2,4                - TERM IN REGISTER 4
         STD      2,0(6,4)           INTO MATRIX (IPIV,JPIV)
         AR       5,2                INCREMENT (IPIV,JCOL)
         AR       6,2                INCREMENT (IPIV,JPIV)
         BXLE     12,10,INNER1
EDGE1    LA       12,8(0,12)
         LA       5,8(0,5)
         LA       6,8(0,6)
         STD      6,0(1,4)           MATRIX (IROW,JPIV) = MRJR
*
*
         LR       2,10
```

```
         CNOP    0,8
INNER2   LD      2,0(6,4)          MATRIX (IPIV,JPIV)
         LD      4,0(5,4)          MATRIX (IPIV,JCOL)
         MDR     4,6               *MRJR
         SDR     2,4               - TERM IN REGISTER 4
         STD     2,0(6,4)          INTO MATRIX (IPIV,JPIV)
         AR      5,2               INCREMENT (IPIV,JCOL)
         AR      6,2               INCREMENT (IPIV,JPIV)
         BXLE    12,2,INNER2
         B       EFFECT
NOEFFECT AR      6,8               REGISTER 6 INCREMENTED IN LOOP
EFFECT   AR      1,8               HASN'T BEEN DONE BY INNER LOOP
         BXLE    7,8,OUTER1        INCREMENT (IROW,JPIV)
*
*
EDGE0    AR      6,8               SINCE R6 HAS MISSED A WHOLE ROW
         AR      7,8               INCREMENT OUTER LOOP INDEX
         AR      1,8               INCREMENT (IROW,JPIV) INDEX
         L       9,NEWLIMIT        NEW OUTER LOOP LIMIT
*
*
*   SECOND OUTER LOOP:
*
*
*
         CNOP    0,8
OUTER2   L       5,JCOLBASE
         SR      12,12             INNER LOOP INDEX REGISTER
         LD      6,0(1,4)          MRJ = MATRIX (IROW,JPIV)
         CD      6,=D'1.E-30'
         BH      MISTERJR          SIGNIFICANTLY POSITIVE
         CD      6,=D'-1.E-30'
         BNL     NOEFECT2          NOT SIGNIFICANTLY NEGATIVE.
MISTERJR MDR     6,0               MRJ * RECIP
         C       12,IROWBASE        IS (IROW-1)=0?   THEN EDGE
         BE      EDGE2
*
*
         CNOP    0,8
INNER3   LD      2,0(6,4)          MATRIX (IPIV,JPIV)
         LD      4,0(5,4)          MATRIX (IPIV,JCOL)
         MDR     4,6               *MRJR
         SDR     2,4               - TERM IN REGISTER 4
         STD     2,0(6,4)          INTO MATRIX (IPIV,JPIV)
         AR      5,2               INCREMENT (IPIV,JCOL)
         AR      6,2               INCREMENT (IPIV,JPIV)
         BXLE    12,10,INNER3
EDGE2    LA      12,8(0,12)
         LA      5,8(0,5)
         LA      6,8(0,6)
         STD     6,0(1,4)          MATRIX (IROW,JPIV) = MRJR
*
*
         LR      2,10
         CNOP    0,8
INNER4   LD      2,0(6,4)          MATRIX (IPIV,JPIV)
         LD      4,0(5,4)          MATRIX (IPIV,JCOL)
         MDR     4,6               *MRJR
         SDR     2,4               - TERM IN REGISTER 4
         STD     2,0(6,4)          INTO MATRIX (IPIV,JPIV)
```

```
          AR      5,2                  INCREMENT (IPIV,JCOL)
          AR      6,2                  INCREMENT (IPIV,JPIV)
          BXLE    12,2,INNER4
          B       EFECT2               REGISTER 6 INCREMENTED IN LOOP
NOEFECT2  AR      6,8                  HASN'T BEEN DONE BY INNER LOOP
EFECT2    AR      1,8                  INCREMENT (IROW,JPIV)
          BXLE    7,8,OUTER2
*
*
*   LOOP TO DO WHAT FORTRAN STATEMENT 40 DID:
*
          SR      12,12                FORTY LOOP INDEX REGISTER
          L       5,JCOLBASE
FORTY     LD      4,0(5,4)             MATRIX (IPIV,JCOL)
          LCDR    4,4                  - MATRIX (IPIV,JCOL)
          MDR     4,0                  * RECIP
          STD     4,0(5,4)
          LA      5,8(0,5)             INCREMENTS (IPIV,JCOL)
          BXLE    12,2,FORTY
          L       5,JCOLBASE
          A       5,IROWBASE
          STD     0,0(5,4)             MATRIX (IROW,JCOL) = RECIP
          LM      14,12,12(13)
          BR      14
*
*
IROWBASE  DS      1F
N         DS      1F
NEWLIMIT  DS      1F
JCOLBASE  DS      1F
          END
 &INPUT
 MAXN=10,
 MAXLSC=4,MAXLS=5,MAXNB=2,MAXLB=4,MAXIE=5,MAXR=10,
 NSENO1=1,1,2,2,3,3,3,3,3,3,
 NSENO2=1,1,2,2,3,3,3,3,3,3,
 NSENO3=0,0,1,1,2,2,2,2,2,2,
 NSENO4=0,0,0,1,2,2,2,2,2,2,
 NSENO5=0,0,0,1,1,2,2,2,2,2,
 IMIXO1=1,0,0,0,
 IMIXO2=1,1,0,0,
 IMIXO3=0,1,0,0,
 IMIXO4=0,0,1,0
 IMIXO5=0,0,1,1,
 IBMIX=1,1,2,2,
 AMTBF1=20.,20.,
 AMTBF2=10.,10.,
        AMTBF3=10.,10.,
  AMTBF4=20.,20.,
 STAND1=1.,1.,
 STAND2=1.,1.,
 STAND3=1.,1.,
 STAND4=1.,1.,
 AMEAN1=20.,20.,
 AMEAN2=10.,10.,
 AMEAN3=7.,5.,
 AMEAN4=20.,20.,
 AMTBS=5.,7.,7.,5.,5.,
 STANDS=1.,4*1.,
 AMEANS=5*5.,
```

```
AMAXC=15.,7.,7.,5.,40.,
AMINC=10.,5.,5.,3.,30.,
CALC=5*100.,
AMAXB=15.,30.,
AMINB=10.,20.,
CALB=100.,100.,
AMAXM=15.,AMINM=10.,CALR=100.,
AMXLC1=12.,20.,22.,20.,20.,
AMNLC1=10.,15.,17.,15.,15.,
CALLC1=5*100.,
AMXLC2=0.,20.,22.,20.,20.,
AMNLC2=0.,15.,17.,15.,15.,
CALLC2=5*100.,
LNCHS1=3*1,3*3,4,4,5,5,
LNCHS2=3*2,3*3,4,4,5,5,
OPBCAP=0,0,PPS=.95,.9,
PBS=.95,.95,PBRS=4*0.,.5,PBRF=5*0.,POS=.95,.95,
POPOF=2*0.,PORBF=2*0.,POR=2*0.,PPMO=1.,1.,.95,.95,.95,
PPMP=.95,.92,.95,.95,.95,
PPMRP=3*0.,.9,.95,
PPLRR=4*0.,.9,
NN=4,DP=10.,DETC=1
      MAXR=1,
      DEBUG=0,
      MAXLB=1,
     AMTBF1=10.,10.,
      AMEAN1=4.0,4.0,
      AMEANS=5.0,5.0,5.0,5.0,3.0,
      AMINC=15.0,7.0,7.0,5.0,40.0,
      AMINB=15.0,30.0,
      AMXLC1=10.0,15.0,17.0,15.0,15.0,
      AMXLC2=0.,15.,17.,15.,15.,
      AMXLC3=0.,15.,17.,15.,15.,
      AMXLC4=0.,15.,17.,15.,15.,
      AMNLC3=0.,15.,17.,15.,15.,
      AMNLC4=0.,15.,17.,15.,15.,
      LNCHS3=2,2,2,3,3,3,4,4,5,5,
      LNCHS4=2,2,2,3,3,3,4,4,5,5,
      AMINM=15.,
      MAXR=10,
      MAXP=100,
      AMTBF1=999.,999.,STAND1=.01,.01,AMTBS=5*999.,STANDS=5*.01,
      PPS=4*1.,PBS=5*1.,PBRS=4*0.,1.,POS=5*1.,PPMO=5*1.,PPMP=5*1.,
      PPMRP=3*0.,2*1.,PPLRR=4*0.,1.,
 SEND
TOTAL LAUNCH COSTS
LAUNCH COSTS (LSC=
TOTAL SPACECRAFT COSTS
SPACECRAFT COSTS (LSC=
TOTAL LAUNCH & SPACECRAFT COSTS
LAUNCH & SPACECRAFT COSTS (LSC=
```

7. SATIL 2 OUTPUT REPORTS

```
&INPUT
MAXNA=        10.,MAXLAC=         4.,MAXLS=          5.,MAXNO=          2.,MAXLD=          1.,MAXIE=          5.,MAXR=         100.,MAXI=
         25.,NOINT=        25.,NSEN01=          1.          1.          2.          2.          3.          3.          3.
         3.          3.          3.          0.          0.          0.          0.          0.          0.          0.          0.
         0.          0.          0.          0.          0.          0.          0.NSEN02=          1.          1.          2.
         2.          3.          3.          3.          3.          3.          3.          0.          0.          0.          0.
         0.          0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
NSEN03=          0.          0.          1.          1.          2.          2.          2.          2.          2.          2.
         0.          0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
         0.          0.          0.          0.NSEN04=          0.          0.          0.          1.          2.          2.
         2.          2.          2.          2.          0.          0.          0.          0.          0.          0.          0.
         0.          0.          0.          0.          0.          0.          0.          0.NSEN05=          0.          0.
         0.          1.          1.          2.          2.          2.          2.          2.          0.          0.          0.
         0.          0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
         0.NSEN06=          0.          0.          0.          0.          0.          0.          0.          0.          0.
         0.          0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
         0.          0.          0.          0.          0.NSEN07=          0.          0.          0.          0.          0.
         0.          0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
         0.          0.          0.          0.          0.          0.          0.          0.          0.NSEN08=          0.
         0.          0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
         0.          0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
         0.          0.NSEN09=          0.          0.          0.          0.          0.          0.          0.          0.
         0.          0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
         0.          0.          0.          0.          0.          0.NSEN10=          0.          0.          0.          0.
         0.          0.          0.          0.          0.          0.          0.          0.          0.          0.          0.
         0.          0.          0.          0.          0.          0.          0.          0.          0.          0.IMIX01=
         1.          0.          0.          0.          0.IMIX02=          1.          1.          0.          0.          0.
IMIX03=          0.          1.          0.          0.          0.IMIX04=          0.          0.          1.          0.
         0.IMIX05=          0.          0.          1.          1.          0.IMIX06=          0.          0.          0.
         0.          0.IMIX07=          0.          0.          0.          0.          0.IMIX08=          0.          0.
         0.          0.          0.IMIX09=          0.          0.          0.          0.          0.IMIX10=          0.
         0.          0.          0.          0.IPMIX=          1.          1.          2.          2.          1.AMTBF1=
  10.000000    , 10.000000    , 5.0000000    , 5.0000000    , 5.0000000    ,AMTBF2=  10.000000    , 10.000000    ,
  5.0000000    , 5.0000000    , 5.0000000    ,AMTBF3=  10.000000    , 10.000000    , 5.0000000    , 5.0000000    ,
  5.0000000    ,AMTBF4=  20.000000    , 20.000000    , 5.0000000    , 5.0000000    , 5.0000000.   ,AMTBF5=  5.0000000    ,
  5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    ,STAND1=  1.0000000    , 1.0000000    , 0.5000000    ,
  0.5000000    , 0.5000000    ,STAND2=  1.0000000    , 1.0000000    , 0.5000000    , 0.5000000    , 0.5000000    ,STAND3=
  1.0000000    , 1.0000000    , 0.5000000    , 0.5000000    , 0.5000000    ,STAND4=  1.0000000    , 1.0000000    ,
  0.5000000    , 0.5000000    , 0.5000000    ,STAND5= 0.5000000    , 0.5000000    , 0.5000000    , 0.5000000    ,
  0.5000000    ,AMTAN1=  5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    ,AMTAN2=  10.000000    ,
  10.000000    , 5.0000000    , 5.0000000    , 5.0000000    ,AMTAN3=  7.0000000    , 5.0000000    , 5.0000000    ,
  5.0000000    , 5.0000000    ,AMTAN4=  20.000000    , 20.000000    , 5.0000000    , 5.0000000    , 5.0000000    ,AMLANS=
  5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    ,AMTNS=  5.0000000    , 7.0000000    ,
  7.0000000    , 5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    ,
STANDS=  1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 5.0000000    , 5.0000000    ,
  5.0000000    , 5.0000000    , 5.0000000    ,AMEANS=  5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    ,
  3.0000000    , 5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    , 5.0000000    ,AMAXC=  15.000000    ,
  7.0000000    , 7.0000000    , 5.0000000    , 40.000000    , 0.0    ,    , 0.0    , 0.0    , 0.0    ,
  0.0          ,AMINC=  15.000000    , 7.0000000    , 7.0000000    , 5.0000000    , 46.000000    , 0.0    ,
  0.0          , 0.0    , 0.0    , 0.0    ,IPI=          16.          16.          16.          16.          16.
         16.          16.          16.          16.          16.CALC=  100.00000    , 100.00000    , 100.00000    , 100.00000    ,
  100.00000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    ,AMAXD=  15.000000    ,
  30.000000    , 0.0    , 0.0    , 0.0    ,AMIND=  15.000000    , 30.000000    , 0.0    ,
  0.0          , 0.0    ,IPID=          16.          16.          16.          16.          16.CALD=  100.00000    ,
  100.00000    , 90.000000    , 90.000000    , 90.000000    ,AMAXM=  15.000000    ,AMINM=  15.000000    ,IPIM=          16.CALR=
  100.00000    ,AMXLC1=  10.000000    , 15.000000    , 17.000000    , 15.000000    , 15.000000    , 0.0    ,
  0.0          , 0.0    , 0.0    , 0.0    ,AMXLC2= 0.0    , 15.000000    , 17.000000    ,
  15.000000    , 15.000000    , 0.0    , 0.0    , 0.0    , 0.0    , 0.0    ,AMXLC3=
  0.0          , 15.000000    , 17.000000    , 15.000000    , 15.000000    , 0.0    , 0.0    , 0.0    ,
```

```
0.0          , 0.0          ,AMXLC4= 0.0              , 15.000000    , 17.000000    , 15.000000    , 15.000000    ,
0.0          , 0.0          , 0.0          , 0.0          , 0.0          ,AMXLC5= 0.0              , 0.0          ,
0.0          , 0.0          , 0.0          , 0.0          , 0.0          , 0.0          , 0.0          , 0.0          ,
AMNLC1=   10.000000    , 15.000000    , 17.000000    , 15.000000    , 15.000000    , 0.0          , 0.0          ,
0.0          , 0.0          , 0.0          ,AMNLC2= 0.0              , 15.000000    , 17.000000    , 15.000000    ,
15.000000    , 0.0          , 0.0          , 0.0          , 0.0          , 0.0          ,AMNLC3= 0.0              ,
15.000000    , 17.000000    , 15.000000    , 15.000000    , 0.0          , 0.0          , 0.0          , 0.0          ,
0.0          ,AMNLC4= 0.0              , 15.000000    , 17.000000    , 15.000000    , 15.000000    , 0.0          ,
0.0          , 0.0          , 0.0          , 0.0          ,AMNLC5= 0.0              , 0.0          , 0.0          ,
0.0          , 0.0          , 0.0          , 0.0          , 0.0          , 0.0          , 0.0          ,IPTLC1=       16.
     16.          16.          16.          16.          16.          16.          16.          16.          16.IPTLC2=       16.
     16.          16.          16.          16.          16.          16.          16.          16.          16.IPTLC3=       16.
     16.          16.          16.          16.          16.          16.          16.          16.          16.IPTLC4=       16.
     16.          16.          16.          16.          16.          16.          16.          16.          16.IPTLC5=       16.
     16.          16.          16.          16.          16.          16.          16.          16.          16.CALLC1=  100.00000    ,
100.00000    , 100.00000    , 100.00000    , 100.00000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    ,
90.000000    ,CALLC2=  100.00000    , 100.00000    , 100.00000    , 100.00000    , 100.00000    , 90.000000    ,
90.000000    , 90.000000    , 90.000000    , 90.000000    ,CALLC3=  90.000000    , 90.000000    , 90.000000    ,
90.000000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    ,CALLC4=
90.000000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    ,
90.000000    , 90.000000    ,CALLC5=  90.000000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    ,
90.000000    , 90.000000    , 90.000000    , 90.000000    , 90.000000    ,LNCHS1=           1.          1.          1.
     3.          3.          3.          4.          4.          5.          5.          1.          1.          1.          1.
     1.          1.          1.          1.          1.          1.          1.          1.          1.          1.          1.
LNCHS2=          2.          2.          2.          3.          3.          3.          4.          4.          5.          5.
     1.          1.          1.          1.          1.          1.          1.          1.          1.          1.          1.
     1.          1.          1.          1.LNCHS3=          2.          2.          2.          3.          3.          3.
     4.          4.          5.          5.          1.          1.          1.          1.          1.          1.          1.
     1.          1.          1.          1.          1.          1.          1.          1.LNCHS4=          2.          2.
     2.          3.          3.          3.          4.          4.          5.          5.          1.          1.          1.
     1.          1.          1.          1.          1.          1.          1.          1.          1.          1.          1.
     1.LNCHS5=          1.          1.          1.          1.          1.          1.          1.          1.          1.
     1.          1.          1.          1.          1.          1.          1.          1.          1.          1.          1.
     1.          1.          1.          1.          1.ORBCAP=          0.          0.          0.          0.          0.PPS=
0.94999999   , 0.94999999   , 1.0000000    , 1.0000000    , 1.0000000    ,PFS= 0.94999999   , 0.94999999   , 1.0000000    ,
1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    ,PBRS=
0.0          , 0.0          , 0.0          , 0.0          , 0.50000000   , 1.0000000    , 1.0000000    , 1.0000000    ,
1.0000000    , 1.0000000    ,PBRF= 0.0              , 0.0          , 0.0          , 0.0          , 0.0          ,
1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    ,PDS= 0.94999999   , 0.94999999   , 1.0000000    ,
1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    ,PCRDF=
0.0          , 0.0          , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    ,
1.0000000    , 1.0000000    ,PDRIF= 0.0              , 0.0          , 1.0000000    , 1.0000000    , 1.0000000    ,
1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    ,PCR= 0.0              , 0.0          , 1.0000000    ,
1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    ,PPPU=
1.0000000    , 1.0000000    , 0.94999999   , 0.94999999   , 0.94999999   , 1.0000000    , 1.0000000    , 1.0000000    ,
1.0000000    , 1.0000000    ,PPPP= 0.94999999   , 0.94999999   , 0.94999999   , 0.94999999   , 0.94999999   ,
1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    ,PPPUP= 0.0              , 0.0          ,
0.0          , 0.94999999   , 0.94999999   , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    , 1.0000000    ,
PPLNR= 0.0              , 0.0          , 0.0          , 0.0          , 0.79999998   , 1.0000000    , 1.0000000    ,
1.0000000    , 1.0000000    , 1.0000000    ,MAXN=          10.          10.          10.          10.          10.NN=          4.DR=
10.000000    ,DELT=            1.PPP01= 0.50000000   , 0.25000000   , 0.14999998   , 0.69999993E-01, 0.29999997E-01,PPP02=
0.29999998   , 0.25000000   , 0.19999999   , 0.14999998   , 0.99999994E-01,PPP03= 0.29999995   , 0.24999995   ,
0.19999999   , 0.13000000   , 0.69999993E-01,PPP04= 0.24999996   , 0.30000000   , 0.14999998   , 0.69999993E-01,
0.29999997E-01,PPP05= 0.[illegible]   , 0.31999996   , 0.[illegible]   , 0.14999998   , 0.69999997E-01,PPP06= 0.22999996   ,
0.[illegible]   , 0.[illegible]   , 0.19999997   , 0.79999992E-01,PPP07= 0.21000000   , 0.24999996   , 0.25000000   ,
0.[illegible]E-01, 0.[illegible]E-01,PPP08= 0.19999997   , 0.42999999   , 0.[illegible]   , 0.[illegible]E-01, 0.30000000E-01,PPP09=
0.11999995   , 0.21999999   , 0.31999999   , 0.16999996   , 0.69999993E-01,PPP10= 0.14999998   , 0.23999997   ,
0.36999995   , 0.11999995   , 0.26000000E-01,PPP11= 0.19999999   , 0.19999999   , 0.19999999   , 0.19999999   ,
0.19999999   ,PPP12= 0.19999999   , 0.19999997   , 0.29999999   , 0.21999997   , 0.14999998   ,PPP13= 0.69999964E-01,
0.21000000   , 0.[illegible]   , 0.21000000   , 0.[illegible]E-01,PPP14= 0.79999993E-01, 0.21000000   , 0.32999997   ,
```

```
 0.25000000     , 0.79999998E-01,PPP15= 0.49999997E-01, 0.75000000     , 0.29999995     , 0.75000000     , 0.49999997E-01,PPP16=
 0.99999994E-01, 0.19999999     , 0.39999998     , 0.19999999     , 0.99999994E-01,PPP17= 0.29999997E-01, 0.29999995     ,
 0.33999997     , 0.29999995     , 0.29999997E-01,PPP18= 0.49999997E-01, 0.15000000     , 0.50000000     , 0.15999999     ,
 0.49999997E-01,PPP19= 0.29999997E-01, 0.19999999     , 0.50000000     , 0.10000000     , 0.29999997E-01,PPP20= 0.29999997E-01,
 0.69999993E-01, 0.79999995     , 0.69999993E-01, 0.29999997E-01,SEDUG=            0
&END
```

PPP

0.50	0.25	0.15	0.07	0.03
0.20	0.25	0.20	0.15	0.10
0.26	0.30	0.26	0.13	0.07
0.35	0.40	0.15	0.07	0.03
0.21	0.22	0.27	0.15	0.05
0.23	0.20	0.23	0.10	0.05
0.25	0.35	0.25	0.10	0.05
0.16	0.45	0.24	0.09	0.02
0.12	0.32	0.32	0.17	0.07
0.15	0.34	0.27	0.12	0.02
0.16	0.20	0.20	0.20	0.20
0.15	0.22	0.26	0.22	0.15
0.10	0.25	0.30	0.25	0.10
0.08	0.25	0.34	0.25	0.08
0.05	0.25	0.40	0.25	0.05
0.10	0.20	0.40	0.20	0.10
0.03	0.30	0.34	0.30	0.03
0.05	0.20	0.50	0.20	0.05
0.03	0.20	0.54	0.20	0.03
0.03	0.07	0.80	0.07	0.03

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: 1

PROBABILITY OF INDICATED QUANTITY

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PMS REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PMS REFURB.	SPACECRAFT REFURB.
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.040	0.040	0.040	0.040	0.040	0.0	0.0	0.0	0.0
2	0.180	0.180	0.180	0.180	0.180	0.0	0.0	0.0	0.0
1	0.780	0.780	0.780	0.780	0.780	0.0	0.0	0.0	0.0
0	0.0	0.0	0.0	0.0	0.0	1.000	1.000	1.000	1.000
EXPECTED NUMBER	1.26	1.26	1.26	1.26	1.26	0.0	0.0	0.0	0.0
STD. DEV.	0.52	0.52	0.52	0.52	0.52	0.0	0.0	0.0	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: 2

PROBABILITY OF INDICATED QUANTITY

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PMS REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PMS REFURB.	SPACECRAFT REFURB.
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.010	0.010	0.010	0.010	0.010	0.0	0.0	0.0	0.0
4	0.010	0.010	0.010	0.010	0.010	0.0	0.0	0.0	0.0
3	0.100	0.100	0.100	0.100	0.100	0.0	0.0	0.0	0.0
2	0.260	0.260	0.260	0.260	0.260	0.0	0.0	0.0	0.0
1	0.620	0.620	0.620	0.620	0.620	0.0	0.0	0.0	0.0
0	0.0	0.0	0.0	0.0	0.0	1.000	1.000	1.000	1.000
EXPECTED NUMBER	1.53	1.53	1.53	1.53	1.53	0.0	0.0	0.0	0.0
STD. DEV.	0.79	0.79	0.79	0.79	0.79	0.0	0.0	0.0	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: 2

PROBABILITY OF INDICATED QUANTITY

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PMS REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PMS REFURB.	SPACECRAFT REFURB.
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.010	0.010	0.010	0.010	0.010	0.0	0.0	0.0	0.0
4	0.010	0.010	0.010	0.010	0.010	0.0	0.0	0.0	0.0
3	0.100	0.100	0.100	0.100	0.100	0.0	0.0	0.0	0.0
2	0.260	0.260	0.260	0.260	0.260	0.0	0.0	0.0	0.0
1	0.620	0.620	0.620	0.620	0.620	0.0	0.0	0.0	0.0
0	0.0	0.0	0.0	0.0	0.0	1.000	1.000	1.000	1.000
EXPECTED NUMBER	1.53	1.53	1.53	1.53	1.53	0.0	0.0	0.0	0.0
STD. DEV.	0.79	0.79	0.79	0.79	0.79	0.0	0.0	0.0	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: 3

PROBABILITY OF INDICATED QUANTITY

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PMS REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PMS REFURB.	SPACECRAFT REFURB.
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.030	0.030	0.030	0.030	0.030	0.0	0.0	0.0	0.0
8	0.020	0.020	0.020	0.020	0.020	0.0	0.0	0.0	0.0
7	0.070	0.070	0.070	0.070	0.070	0.0	0.0	0.0	0.0
6	0.110	0.110	0.110	0.110	0.110	0.0	0.0	0.0	0.0
5	0.340	0.340	0.340	0.340	0.340	0.0	0.0	0.0	0.0
4	0.380	0.380	0.380	0.380	0.380	0.0	0.0	0.0	0.0
3	0.050	0.050	0.050	0.050	0.050	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	0.0	0.0	0.0	0.0	0.0	1.000	1.000	1.000	1.000
EXPECTED NUMBER	4.95	4.95	4.95	4.95	4.95	0.0	0.0	0.0	0.0
STD. DEV.	1.28	1.28	1.28	1.26	1.26	0.0	0.0	0.0	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: 4

PROBABILITY OF INDICATED QUANTITY

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PMS REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PMS REFURB.	SPACECRAFT REFURB.
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.010	0.010	0.0	0.010	0.010	0.0	0.010	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.040	0.040	0.0	0.030	0.030	0.0	0.040	0.0	0.0
2	0.190	0.190	0.0	0.190	0.190	0.0	0.190	0.0	0.0
1	0.440	0.440	0.0	0.450	0.450	0.0	0.440	0.020	0.0
0	0.320	0.320	1.000	0.320	0.320	1.000	0.320	0.980	1.000
EXPECTED NUMBER	0.99	0.99	0.0	0.97	0.97	0.0	0.99	0.02	0.0
STD. DEV.	0.91	0.91	0.0	0.89	0.89	0.0	0.91	0.14	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: [illegible]

PROBABILITY OF INDICATED QUANTITY

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PMS REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PMS REFURB.	SPACECRAFT REFURB.
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.010	0.010	0.0	0.0	0.0	0.0	0.010	0.0	0.0
9	0.070	0.070	0.0	0.030	0.030	0.0	0.070	0.0	0.0
8	0.150	0.150	0.0	0.090	0.090	0.0	0.150	0.0	0.0
7	0.190	0.190	0.0	0.216	0.210	0.0	0.190	0.0	0.0
6	0.330	0.320	0.0	0.396	0.390	0.0	0.320	0.0	0.0
5	0.210	0.210	0.0	0.220	0.220	0.0	0.210	0.0	0.0
4	0.040	0.040	0.0	0.050	0.050	0.0	0.040	0.010	0.0
3	0.0	0.0	0.0	0.010	0.010	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.070	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.140	0.0
0	0.0	0.0	1.000	0.0	0.0	1.000	0.0	0.780	1.000
EXPECTED NUMBER	6.45	6.45	0.0	6.13	6.13	0.0	6.45	0.32	0.0
STD. DEV.	1.32	1.32	0.0	1.15	1.15	0.0	1.32	0.69	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: 6

PROBABILITY OF INDICATED QUANTITY

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PMS REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PMS REFURB.	SPACECRAFT REFURB.
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.040	0.040	0.0	0.020	0.020	0.0	0.040	0.0	0.0
5	0.040	0.040	0.0	0.040	0.040	0.0	0.040	0.0	0.0
4	0.170	0.170	0.0	0.180	0.180	0.0	0.170	0.0	0.0
3	0.240	0.240	0.0	0.220	0.220	0.0	0.240	0.0	0.0
2	0.260	0.260	0.0	0.290	0.290	0.0	0.260	0.0	0.0
1	0.150	0.150	0.0	0.150	0.150	0.0	0.150	0.080	0.0
0	0.100	0.100	1.000	0.100	0.100	1.000	0.100	0.920	1.000
EXPECTED NUMBER	2.51	2.51	0.0	2.43	2.43	0.0	2.51	0.08	0.0
STD. DEV.	1.49	1.49	0.0	1.41	1.41	0.0	1.49	0.27	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: 7

PROBABILITY OF INDICATED QUANTITY

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PMS REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PMS REFURB.	SPACECRAFT REFURB.
11	0.010	0.010	0.0	0.0	0.0	0.0	0.010	0.0	0.0
10	0.010	0.010	0.0	0.0	0.020	0.0	0.010	0.0	0.0
9	0.020	0.020	0.0	0.0	0.010	0.0	0.020	0.010	0.0
8	0.030	0.030	0.0	0.0	0.010	0.0	0.030	0.010	0.0
7	0.080	0.080	0.0	0.0	0.080	0.0	0.080	0.040	0.0
6	0.170	0.170	0.0	0.0	0.140	0.0	0.170	0.150	0.0
5	0.310	0.310	0.0	0.010	0.320	0.0	0.310	0.220	0.0
4	0.220	0.220	0.0	0.010	0.250	0.0	0.220	0.250	0.0
3	0.120	0.120	0.0	0.0	0.140	0.0	0.120	0.250	0.0
2	0.030	0.030	0.0	0.150	0.030	0.0	0.030	0.060	0.0
1	0.0	0.0	0.0	0.340	0.0	0.0	0.0	0.010	0.0
0	0.0	0.0	1.000	0.490	0.0	1.000	0.0	0.0	1.000
EXPECTED NUMBER	5.06	5.06	0.0	0.73	4.85	0.0	5.06	4.33	0.0
STD. DEV.	1.63	1.63	0.0	0.90	1.51	0.0	1.63	1.44	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: 8

PROBABILITY OF INDICATED QUANTITY

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PMS REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PMS REFURB.	SPACECRAFT REFURB.
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.100	0.100	0.0	0.0	0.040	0.0	0.100	0.030	0.0
5	0.180	0.180	0.0	0.0	0.170	0.0	0.180	0.110	0.0
4	0.160	0.160	0.0	0.0	0.190	0.0	0.160	0.230	0.0
3	0.290	0.290	0.0	0.0	0.280	0.0	0.290	0.200	0.0
2	0.170	0.170	0.0	0.050	0.220	0.0	0.170	0.280	0.0
1	0.090	0.090	0.0	0.420	0.090	0.0	0.090	0.110	0.0
0	0.010	0.010	1.000	0.530	0.010	1.000	0.010	0.040	1.000
EXPECTED NUMBER	3.44	3.44	0.0	0.52	3.22	0.0	3.44	2.92	0.0
STD. DEV.	1.49	1.49	0.0	0.59	1.36	0.0	1.49	1.42	0.0

172

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: 9

PROBABILITY OF INDICATED QUANTITY

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PMS REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PMS REFURB.	SPACECRAFT REFURB.
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.020	0.0	0.0	0.0	0.0	0.0	0.020	0.010	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.060	0.0	0.0	0.0	0.030	0.0	0.060	0.010	0.0
6	0.150	0.010	0.0	0.0	0.120	0.010	0.150	0.080	0.0
5	0.240	0.030	0.0	0.0	0.220	0.0	0.240	0.220	0.0
4	0.240	0.110	0.0	0.010	0.330	0.150	0.240	0.320	0.0
3	0.190	0.240	0.0	0.020	0.180	0.230	0.190	0.200	0.0
2	0.090	0.320	0.0	0.060	0.110	0.300	0.090	0.130	0.010
1	0.010	0.230	0.0	0.290	0.010	0.220	0.010	0.030	0.120
0	0.0	0.060	1.000	0.620	0.0	0.080	0.0	0.0	0.870
EXPECTED NUMBER	4.42	2.24	0.0	0.51	4.12	2.18	4.42	3.91	0.14
STD. DEV.	1.53	1.23	0.0	0.78	1.29	1.25	1.53	1.36	0.27

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

YEAR: 10

PROBABILITY OF INDICATED QUANTITY

QUANTITY	LAUNCH ATTEMPTS	ADDIT. BOOSTERS REQUIRED	ADDIT. ORBITERS REQUIRED	ADDIT. PMS REQUIRED	SPACECRAFT REQUIRED	BOOSTERS REFURB.	ORBITERS REFURB.	PMS REFURB.	SPACECRAFT REFURB.
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.020	0.0	0.0	0.0	0.010	0.0	0.020	0.0	0.0
7	0.040	0.0	0.0	0.0	0.020	0.0	0.040	0.0	0.0
6	0.030	0.0	0.0	0.0	0.040	0.010	0.030	0.040	0.0
5	0.150	0.010	0.0	0.0	0.110	0.040	0.150	0.100	0.0
4	0.260	0.080	0.0	0.0	0.230	0.070	0.260	0.310	0.0
3	0.230	0.170	0.0	0.020	0.330	0.140	0.230	0.260	0.0
2	0.210	0.300	0.0	0.030	0.210	0.290	0.210	0.250	0.0
1	0.020	0.330	0.0	0.220	0.030	0.270	0.020	0.020	0.070
0	0.020	0.110	1.000	0.730	0.020	0.180	0.020	0.020	0.930
EXPECTED NUMBER	3.62	1.31	0.0	0.34	3.37	1.81	3.62	3.28	0.07
STD. DEV.	1.54	1.15	0.0	0.64	1.40	1.38	1.54	1.23	0.26

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED TOTAL LAUNCH COSTS

COST RANGE (MILLIONS OF DOLLARS)										
163.20--- 170.00	0.0	0.0	0.0	0.0	0.010	0.0	0.010	0.0	0.0	0.0
156.40--- 163.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
149.60--- 156.40	0.0	0.0	0.0	0.0	0.070	0.0	0.010	0.0	0.0	0.0
142.80--- 149.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
136.00--- 142.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
129.20--- 136.00	0.0	0.0	0.0	0.0	0.150	0.0	0.020	0.0	0.020	0.0
122.40--- 129.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
115.60--- 122.40	0.0	0.0	0.0	0.0	0.190	0.0	0.030	0.0	0.0	0.020
108.80--- 115.60	0.0	0.0	0.020	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102.00--- 108.80	0.0	0.0	0.020	0.0	0.0	0.0	0.060	0.0	0.060	0.040
95.20--- 102.00	0.0	0.0	0.0	0.0	0.330	0.040	0.0	0.0	0.0	0.0
88.40--- 95.20	0.0	0.0	0.010	0.0	0.0	0.0	0.170	0.100	0.150	0.030
81.60--- 88.40	0.0	0.0	0.0	0.010	0.210	0.040	0.0	0.0	0.0	0.0
74.80--- 81.60	0.0	0.0	0.090	0.0	0.0	0.0	0.310	0.180	0.240	0.150
68.00--- 74.80	0.0	0.010	0.080	0.0	0.0	0.0	0.0	0.0	0.0	0.0
61.20--- 68.00	0.0	0.0	0.030	0.0	0.040	0.170	0.0	0.0	0.0	0.0
54.40--- 61.20	0.0	0.010	0.320	0.0	0.0	0.0	0.220	0.160	0.240	0.280
47.60--- 54.40	0.0	0.0	0.040	0.040	0.0	0.240	0.0	0.0	0.0	0.0
40.80--- 47.60	0.0	0.040	0.340	0.0	0.0	0.0	0.120	0.290	0.190	0.220
34.00--- 40.80	0.0	0.060	0.050	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27.20--- 34.00	0.040	0.160	0.0	0.190	0.0	0.260	0.030	0.170	0.090	0.210
20.40--- 27.20	0.0	0.160	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13.60--- 20.40	0.180	0.620	0.0	0.440	0.0	0.150	0.0	0.090	0.010	0.020
6.80--- 13.60	0.780	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 6.80	0.0	0.0	0.0	0.320	0.0	0.100	0.0	0.010	0.0	0.020
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	12.6	21.7	57.3	16.6	109.6	42.7	75.9	51.6	66.3	54.3
STD. DEV.	5.2	10.6	15.6	15.5	22.5	25.3	24.4	22.3	23.0	23.1

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED TOTAL SPACECRAFT COSTS

COST RANGE (MILLIONS OF DOLLARS)										
501.12--- 522.00	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0
480.24--- 501.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
459.36--- 480.24	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0
438.48--- 459.36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
417.60--- 438.48	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0
396.72--- 417.60	0.0	0.0	0.0	0.0	0.0	0.0	0.020	0.0	0.010	0.0
375.84--- 396.72	0.0	0.0	0.0	0.0	0.020	0.0	0.0	0.0	0.0	0.0
354.96--- 375.84	0.0	0.0	0.0	0.0	0.050	0.0	0.030	0.0	0.0	0.010
334.08--- 354.96	0.0	0.0	0.0	0.0	0.040	0.0	0.010	0.0	0.0	0.010
313.20--- 334.08	0.0	0.0	0.0	0.0	0.220	0.0	0.030	0.0	0.030	0.0
292.32--- 313.20	0.0	0.0	0.010	0.0	0.020	0.0	0.050	0.010	0.010	0.030
271.44--- 292.32	0.0	0.0	0.020	0.0	0.340	0.0	0.070	0.030	0.090	0.040
250.56--- 271.44	0.0	0.0	0.020	0.0	0.150	0.020	0.220	0.070	0.090	0.040
229.68--- 250.56	0.0	0.0	0.070	0.0	0.020	0.0	0.020	0.040	0.020	0.0
208.80--- 229.68	0.0	0.0	0.0	0.0	0.070	0.080	0.180	0.080	0.250	0.140
187.92--- 208.80	0.0	0.0	0.110	0.0	0.010	0.020	0.040	0.030	0.040	0.030
167.04--- 187.92	0.0	0.0	0.130	0.010	0.030	0.120	0.170	0.130	0.180	0.180
146.16--- 167.04	0.0	0.0	0.210	0.020	0.0	0.070	0.060	0.140	0.060	0.120
125.28--- 146.16	0.0	0.0	0.360	0.010	0.010	0.100	0.020	0.110	0.060	0.110
104.40--- 125.28	0.040	0.010	0.0	0.040	0.0	0.150	0.010	0.110	0.040	0.100
83.52--- 104.40	0.0	0.030	0.050	0.010	0.0	0.060	0.010	0.080	0.030	0.050
62.64--- 83.52	0.180	0.080	0.0	0.190	0.0	0.170	0.030	0.070	0.090	0.100
41.76--- 62.64	0.0	0.260	0.0	0.020	0.0	0.0	0.0	0.010	0.0	0.0
20.88--- 41.76	0.780	0.620	0.0	0.280	0.0	0.110	0.0	0.080	0.0	0.010
0.0 --- 20.88	0.0	0.0	0.0	0.320	0.0	0.100	0.0	0.010	0.0	0.020
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	46.6	37.4	164.1	39.5	290.7	111.9	231.4	151.6	198.2	165.5
STD. DEV.	19.3	22.5	41.9	38.8	51.5	67.2	72.1	68.9	68.1	69.2

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED TOTAL LAUNCH & SPACECRAFT COSTS

COST RANGE (MILLIONS OF DOLLARS)										
659.52--- 687.00	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0
632.04--- 659.52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
604.56--- 632.04	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0
577.08--- 604.56	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0
549.60--- 577.08	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0
522.12--- 549.60	0.0	0.0	0.0	0.0	0.020	0.0	0.010	0.0	0.010	0.0
494.64--- 522.12	0.0	0.0	0.0	0.0	0.030	0.0	0.0	0.0	0.0	0.0
467.16--- 494.64	0.0	0.0	0.0	0.0	0.080	0.0	0.030	0.0	0.0	0.010
439.68--- 467.16	0.0	0.0	0.0	0.0	0.150	0.0	0.010	0.0	0.0	0.010
412.20--- 439.68	0.0	0.0	0.0	0.0	0.110	0.0	0.030	0.0	0.040	0.010
384.72--- 412.20	0.0	0.0	0.030	0.0	0.210	0.0	0.070	0.010	0.010	0.0
357.24--- 384.72	0.0	0.0	0.010	0.0	0.090	0.0	0.050	0.030	0.060	0.060
329.76--- 357.24	0.0	0.0	0.010	0.0	0.170	0.030	0.170	0.050	0.070	0.020
302.28--- 329.76	0.0	0.0	0.070	0.0	0.020	0.010	0.090	0.070	0.100	0.020
274.80--- 302.28	0.0	0.0	0.0	0.0	0.060	0.080	0.200	0.110	0.220	0.150
247.32--- 274.80	0.0	0.0	0.110	0.010	0.010	0.040	0.020	0.020	0.060	0.050
219.84--- 247.32	0.0	0.0	0.320	0.0	0.030	0.080	0.160	0.120	0.130	0.160
192.36--- 219.84	0.0	0.010	0.020	0.010	0.0	0.130	0.070	0.150	0.060	0.110
164.88--- 192.36	0.0	0.0	0.380	0.020	0.0	0.050	0.020	0.080	0.040	0.130
137.40--- 164.88	0.040	0.010	0.0	0.050	0.0	0.200	0.020	0.170	0.070	0.120
109.92--- 137.40	0.0	0.100	0.050	0.010	0.0	0.010	0.0	0.040	0.010	0.030
82.44--- 109.92	0.180	0.160	0.0	0.200	0.0	0.160	0.030	0.060	0.050	0.090
54.96--- 82.44	0.0	0.100	0.0	0.010	0.0	0.0	0.0	0.0	0.0	0.010
27.48--- 54.96	0.780	0.620	0.0	0.370	0.0	0.110	0.0	0.080	0.0	0.0
0.0 --- 27.48	0.0	0.0	0.0	0.320	0.0	0.100	0.0	0.010	0.0	0.020
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	59.2	59.1	221.4	56.3	400.4	154.6	307.3	203.2	264.5	219.8
STD. DEV.	24.5	32.4	57.1	53.2	70.9	90.6	94.8	89.0	88.2	90.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED LAUNCH COSTS (LSC= 1)

COST RANGE (MILLIONS OF DOLLARS)										
100.80--- 105.00	0.0	0.0	0.0	0.0	0.020	0.0	0.010	0.0	0.0	0.0
96.60--- 100.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92.40--- 96.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
88.20--- 92.40	0.0	0.0	0.0	0.0	0.0	0.0	0.020	0.0	0.010	0.010
84.00--- 88.20	0.0	0.0	0.0	0.0	0.020	0.0	0.0	0.0	0.0	0.0
79.80--- 84.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75.60--- 79.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
71.40--- 75.60	0.0	0.0	0.0	0.0	0.0	0.0	0.040	0.010	0.030	0.010
67.20--- 71.40	0.0	0.0	0.0	0.010	0.210	0.010	0.0	0.0	0.0	0.0
63.00--- 67.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
58.80--- 63.00	0.0	0.0	0.0	0.0	0.0	0.0	0.160	0.030	0.120	0.060
54.60--- 58.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50.40--- 54.60	0.0	0.0	0.0	0.0	0.390	0.110	0.0	0.0	0.0	0.0
46.20--- 50.40	0.0	0.0	0.020	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42.00--- 46.20	0.0	0.0	0.0	0.0	0.0	0.0	0.290	0.150	0.260	0.110
37.80--- 42.00	0.0	0.0	0.070	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33.60--- 37.80	0.0	0.0	0.0	0.100	0.320	0.280	0.0	0.0	0.0	0.0
29.40--- 33.60	0.040	0.0	0.180	0.0	0.0	0.0	0.260	0.290	0.370	0.370
25.20--- 29.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21.00--- 25.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16.80--- 21.00	0.180	0.020	0.610	0.340	0.040	0.350	0.0	0.0	0.0	0.0
12.60--- 16.80	0.0	0.0	0.0	0.0	0.0	0.0	0.120	0.340	0.200	0.330
8.40--- 12.60	0.780	0.210	0.120	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.20--- 8.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 4.20	0.0	0.770	0.0	0.550	0.0	0.250	0.0	0.180	0.010	0.110
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	12.6	2.5	22.6	9.9	49.5	21.3	41.1	23.1	36.1	26.3
STD. DEV.	5.2	4.8	8.3	12.8	16.5	16.7	18.0	16.5	16.7	17.2

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED LAUNCH COSTS (LSC= 2)

COST RANGE (MILLIONS OF DOLLARS)	1	2	3	4	5	6	7	8	9	10
65.28--- 68.00	0.0	0.0	0.0	0.0	0.030	0.010	0.0	0.0	0.0	0.0
62.56--- 65.28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59.84--- 62.56	0.0	0.020	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.020
57.12--- 59.84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
54.40--- 57.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51.68--- 54.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48.96--- 51.68	0.0	0.0	0.0	0.0	0.060	0.020	0.0	0.0	0.0	0.0
46.24--- 48.96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
43.52--- 46.24	0.0	0.040	0.010	0.0	0.0	0.0	0.050	0.030	0.010	0.020
40.80--- 43.52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
38.08--- 40.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35.36--- 38.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32.64--- 35.36	0.0	0.0	0.0	0.030	0.280	0.070	0.0	0.0	0.0	0.0
29.92--- 32.64	0.0	0.140	0.050	0.0	0.0	0.0	0.050	0.170	0.140	0.060
27.20--- 29.92	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24.48--- 27.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21.76--- 24.48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19.04--- 21.76	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16.32--- 19.04	0.0	0.0	0.0	0.200	0.600	0.290	0.0	0.0	0.0	0.0
13.60--- 16.32	0.0	0.800	0.130	0.0	0.0	0.0	0.390	0.360	0.360	0.350
10.88--- 13.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8.16--- 10.88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5.44--- 8.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2.72--- 5.44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 2.72	1.000	0.0	0.810	0.770	0.030	0.610	0.470	0.440	0.490	0.530
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	0.0	19.2	3.9	4.4	24.8	9.0	11.1	11.8	10.0	9.8
STD. DEV.	0.0	9.5	8.9	8.5	13.3	13.5	13.2	12.4	11.2	13.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED LAUNCH COSTS (LSC= 3)

COST RANGE (MILLIONS OF DOLLARS)											
85.30---	88.85	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0	0.0	0.0
81.74---	85.30	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0
78.19---	81.74	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
74.63---	78.19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0
71.08---	74.63	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
67.53---	71.08	0.0	0.0	0.0	0.0	0.040	0.0	0.0	0.0	0.0	0.0
63.97---	67.53	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60.42---	63.97	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56.86---	60.42	0.0	0.0	0.0	0.0	0.0	0.0	0.040	0.0	0.0	0.0
53.31---	56.86	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49.76---	53.31	0.0	0.0	0.070	0.0	0.060	0.0	0.0	0.0	0.0	0.0
46.20---	49.76	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
42.65---	46.20	0.0	0.0	0.0	0.0	0.0	0.0	0.020	0.040	0.040	0.040
39.09---	42.65	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35.54---	39.09	0.0	0.0	0.210	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31.99---	35.54	0.0	0.0	0.0	0.010	0.800	0.180	0.0	0.0	0.0	0.0
28.43---	31.99	0.0	0.0	0.0	0.0	0.0	0.0	0.490	0.320	0.380	0.320
24.88---	28.43	0.0	0.0	0.700	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21.32---	24.88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17.77---	21.32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.22---	17.77	0.0	0.0	0.0	0.130	0.090	0.370	0.380	0.350	0.410	0.460
10.66---	14.22	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.11---	10.66	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.55---	7.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	3.55	1.000	1.000	0.0	0.860	0.0	0.450	0.070	0.290	0.160	0.180
YEAR		1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS		0.0	0.0	30.8	2.5	35.4	12.4	23.7	16.6	20.1	18.2
STD. DEV.		0.0	0.0	10.2	6.5	10.7	12.7	12.2	13.1	12.9	11.7

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED LAUNCH COSTS (LSC= 4)

COST RANGE (MILLIONS OF DOLLARS)											
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 ---	0.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
YEAR		1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STD. DEV.		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED SPACECRAFT COSTS (LSC= 1)

COST RANGE (MILLIONS OF DOLLARS)										
13.12--- 222.00	0.0	0.0	0.0	0.0	0.0	0.0	0.030	0.0	0.0	0.0
04.24--- 213.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
95.36--- 204.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
86.48--- 195.36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
77.60--- 186.48	0.0	0.0	0.020	0.0	0.020	0.0	0.020	0.0	0.010	0.010
68.72--- 177.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
59.84--- 168.72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50.96--- 159.84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0
42.08--- 150.96	0.0	0.0	0.070	0.010	0.150	0.010	0.140	0.040	0.040	0.020
33.20--- 142.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24.32--- 133.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.44--- 124.32	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.040	0.020
06.56--- 115.44	0.040	0.0	0.180	0.0	0.470	0.100	0.320	0.100	0.280	0.090
97.68--- 106.56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
88.80--- 97.68	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
79.92--- 88.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
71.04--- 79.92	0.180	0.020	0.610	0.080	0.320	0.230	0.370	0.330	0.400	0.380
62.16--- 71.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
53.28--- 62.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44.40--- 53.28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35.52--- 44.40	0.780	0.210	0.120	0.360	0.040	0.410	0.120	0.350	0.210	0.370
26.64--- 35.52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17.76--- 26.64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8.88--- 17.76	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 8.88	0.0	0.770	0.0	0.550	0.0	0.250	0.0	0.180	0.010	0.110
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	46.6	9.3	83.6	20.7	103.2	44.8	98.4	54.4	82.6	59.0
STD. DEV.	19.3	17.6	30.8	26.8	30.2	35.6	40.9	37.9	33.8	35.7

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED SPACECRAFT COSTS (LSC= 2)

COST RANGE (MILLIONS OF DOLLARS)										
111.36--- 116.00	0.0	0.0	0.0	0.0	0.010	0.010	0.010	0.0	0.0	0.0
106.72--- 111.36	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
102.08--- 106.72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
97.44--- 102.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
92.80--- 97.44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
88.16--- 92.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.020
83.52--- 88.16	0.0	0.020	0.010	0.0	0.060	0.020	0.010	0.020	0.0	0.010
78.88--- 83.52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
74.24--- 78.88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
69.60--- 74.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
64.96--- 69.60	0.0	0.040	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
60.32--- 64.96	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.010
55.68--- 60.32	0.0	0.0	0.050	0.030	0.250	0.070	0.100	0.140	0.070	0.050
51.04--- 55.68	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
46.40--- 51.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41.76--- 46.40	0.0	0.140	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37.12--- 41.76	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32.48--- 37.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.050	0.010
27.84--- 32.48	0.0	0.0	0.130	0.200	0.650	0.290	0.410	0.400	0.360	0.370
23.20--- 27.84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18.56--- 23.20	0.0	0.800	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13.92--- 18.56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9.28--- 13.92	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.64--- 9.28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 4.64	1.000	0.0	0.810	0.770	0.030	0.610	0.470	0.440	0.490	0.530
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	0.0	28.2	7.5	7.5	39.7	15.4	19.7	21.5	17.4	17.3
STD. DEV.	0.0	13.9	17.2	14.6	19.9	23.0	22.4	22.3	18.6	21.8

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED SPACECRAFT COSTS (LSC= 3)

COST RANGE (MILLIONS OF DOLLARS)										
288.00--- 300.00	0.0	0.0	0.0	0.0	0.010	0.0	0.010	0.0	0.010	0.0
276.00--- 288.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
264.00--- 276.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
252.00--- 264.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
240.00--- 252.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
228.00--- 240.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
216.00--- 228.00	0.0	0.0	0.0	0.0	0.070	0.0	0.040	0.0	0.030	0.020
204.00--- 216.00	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0	0.0	0.0
192.00--- 204.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
180.00--- 192.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
168.00--- 180.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
156.00--- 168.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
144.00--- 156.00	0.0	0.0	0.010	0.010	0.800	0.140	0.470	0.300	0.380	0.310
132.00--- 144.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
120.00--- 132.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
108.00--- 120.00	0.0	0.0	0.070	0.0	0.0	0.0	0.0	0.0	0.0	0.0
96.00--- 108.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
84.00--- 96.00	0.0	0.0	0.210	0.0	0.0	0.0	0.0	0.0	0.0	0.0
72.00--- 84.00	0.0	0.0	0.0	0.130	0.120	0.410	0.410	0.410	0.420	0.460
60.00--- 72.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48.00--- 60.00	0.0	0.0	0.700	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36.00--- 48.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24.00--- 36.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12.00--- 24.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 12.00	1.000	1.000	0.0	0.860	0.0	0.450	0.070	0.290	0.160	0.180
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	0.0	0.0	72.9	11.3	147.8	81.8	113.3	75.8	98.3	89.2
STD. DEV.	0.0	0.0	24.1	28.8	35.9	52.7	54.6	57.6	60.6	56.8

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED SPACECRAFT COSTS (LSC= 4)

COST RANGE (MILLIONS OF DOLLARS)										
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STD. DEV.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED LAUNCH & SPACECRAFT COSTS (LSC= 1)

COST RANGE (MILLIONS OF DOLLARS)										
313.92--- 327.00	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0
300.84--- 313.92	0.0	0.0	0.0	0.0	0.0	0.0	0.020	0.0	0.0	0.0
287.76--- 300.84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
274.68--- 287.76	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0
261.60--- 274.68	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0
248.52--- 261.60	0.0	0.0	0.0	0.0	0.0	0.0	0.020	0.0	0.020	0.010
235.44--- 248.52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
222.36--- 235.44	0.0	0.0	0.020	0.0	0.0	0.0	0.020	0.010	0.0	0.0
209.28--- 222.36	0.0	0.0	0.0	0.010	0.160	0.010	0.0	0.0	0.0	0.0
196.20--- 209.28	0.0	0.0	0.0	0.0	0.0	0.0	0.120	0.030	0.040	0.030
183.12--- 196.20	0.0	0.0	0.070	0.0	0.010	0.0	0.0	0.0	0.020	0.0
170.04--- 183.12	0.0	0.0	0.0	0.0	0.060	0.0	0.030	0.0	0.070	0.030
156.96--- 170.04	0.0	0.0	0.0	0.0	0.390	0.100	0.0	0.0	0.0	0.0
143.88--- 156.96	0.0	0.0	0.0	0.0	0.0	0.0	0.290	0.100	0.230	0.070
130.80--- 143.88	0.040	0.0	0.180	0.0	0.0	0.0	0.010	0.0	0.010	0.010
117.72--- 130.80	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.050	0.030	0.030
104.64--- 117.72	0.0	0.0	0.0	0.080	0.320	0.220	0.0	0.0	0.0	0.0
91.56--- 104.64	0.180	0.020	0.610	0.0	0.0	0.0	0.360	0.280	0.360	0.340
78.48--- 91.56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.010
65.40--- 78.48	0.0	0.0	0.0	0.020	0.0	0.030	0.0	0.010	0.010	0.030
52.32--- 65.40	0.0	0.0	0.0	0.340	0.040	0.380	0.0	0.0	0.0	0.0
39.24--- 52.32	0.780	0.210	0.120	0.0	0.0	0.0	0.120	0.340	0.200	0.330
26.16--- 39.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13.08--- 26.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 13.08	0.0	0.770	0.0	0.550	0.0	0.250	0.0	0.180	0.010	0.110
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	59.2	11.8	106.2	30.6	152.7	66.0	129.5	77.5	115.7	85.2
STD. DEV.	24.5	22.4	39.1	39.5	45.6	52.1	58.5	54.1	49.6	51.8

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED LAUNCH & SPACECRAFT COSTS (LSC= .2)

COST RANGE (MILLIONS OF DOLLARS)										
176.64--- 184.00	0.0	0.0	0.0	0.0	0.010	0.010	0.0	0.0	0.0	0.0
169.28--- 176.64	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0
161.92--- 169.28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
154.56--- 161.92	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0
147.20--- 154.56	0.0	0.020	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.020
139.84--- 147.20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
132.48--- 139.84	0.0	0.0	0.0	0.0	0.050	0.020	0.0	0.0	0.0	0.0
125.12--- 132.48	0.0	0.0	0.010	0.0	0.010	0.0	0.010	0.020	0.0	0.010
117.76--- 125.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
110.40--- 117.76	0.0	0.040	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103.04--- 110.40	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.010	0.010
95.68--- 103.04	0.0	0.0	0.0	0.0	0.0	0.0	0.040	0.010	0.0	0.0
88.32--- 95.68	0.0	0.0	0.0	0.030	0.230	0.070	0.0	0.0	0.0	0.0
80.96--- 88.32	0.0	0.0	0.050	0.0	0.0	0.0	0.060	0.130	0.070	0.050
73.60--- 80.96	0.0	0.140	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
66.24--- 73.60	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
58.88--- 66.24	0.0	0.0	0.0	0.0	0.050	0.0	0.020	0.040	0.070	0.030
51.52--- 58.88	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
44.16--- 51.52	0.0	0.0	0.0	0.200	0.600	0.290	0.0	0.0	0.0	0.0
36.80--- 44.16	0.0	0.800	0.130	0.0	0.0	0.0	0.390	0.360	0.360	0.350
29.44--- 36.80	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22.08--- 29.44	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14.72--- 22.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7.36--- 14.72	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 7.36	1.000	0.0	0.810	0.770	0.030	0.610	0.470	0.440	0.490	0.530
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	0.0	47.4	11.4	12.0	64.5	24.4	30.6	33.3	27.4	27.0
STD. DEV.	0.0	23.4	26.1	23.1	37.5	36.5	35.3	34.5	29.5	34.5

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED LAUNCH & SPACECRAFT COSTS (LSC# 3)

COST RANGE (MILLIONS OF DOLLARS)										
360.00--- 375.00	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.010	0.0
345.00--- 360.00	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0
330.00--- 345.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
315.00--- 330.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
300.00--- 315.00	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0
285.00--- 300.00	0.0	0.0	0.010	0.0	0.010	0.0	0.0	0.0	0.0	0.0
270.00--- 285.00	0.0	0.0	0.0	0.0	0.050	0.0	0.030	0.0	0.0	0.0
255.00--- 270.00	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.030	0.030
240.00--- 255.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
225.00--- 240.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
210.00--- 225.00	0.0	0.0	0.010	0.0	0.020	0.0	0.0	0.0	0.0	0.0
195.00--- 210.00	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0
180.00--- 195.00	0.0	0.0	0.0	0.010	0.770	0.140	0.010	0.030	0.010	0.010
165.00--- 180.00	0.0	0.0	0.070	0.0	0.0	0.0	0.460	0.270	0.370	0.300
150.00--- 165.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
135.00--- 150.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
120.00--- 135.00	0.0	0.0	0.210	0.0	0.0	0.0	0.0	0.0	0.0	0.0
105.00--- 120.00	0.0	0.0	0.0	0.0	0.030	0.040	0.0	0.010	0.0	0.0
90.00--- 105.00	0.0	0.0	0.0	0.130	0.090	0.370	0.030	0.050	0.010	0.020
75.00--- 90.00	0.0	0.0	0.700	0.0	0.0	0.0	0.380	0.350	0.410	0.460
60.00--- 75.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
45.00--- 60.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30.00--- 45.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15.00--- 30.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 15.00	1.000	1.000	0.0	0.860	0.0	0.450	0.070	0.290	0.160	0.180
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	0.0	0.0	103.7	13.8	183.1	64.2	137.0	92.4	118.4	107.6
STD. DEV.	0.0	0.0	34.3	35.3	44.7	65.0	66.3	69.9	73.4	68.3

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PROBABILITY OF INDICATED LAUNCH & SPACECRAFT COSTS (LSC= 4)

COST RANGE (MILLIONS OF DOLLARS)										
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0 --- 0.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED COSTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STD. DEV.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

SPACECRAFT TYPE : 1

PROBABILITY OF INDICATED LAUNCH ATTEMPTS

QUANTITY										
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.010	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.020	0.0	0.020	0.0	0.010	0.010
5	0.0	0.0	0.020	0.0	0.020	0.0	0.040	0.010	0.030	0.010
4	0.0	0.0	0.070	0.010	0.210	0.010	0.160	0.030	0.120	0.060
3	0.040	0.0	0.180	0.0	0.390	0.110	0.290	0.150	0.260	0.110
2	0.180	0.020	0.610	0.100	0.320	0.250	0.360	0.290	0.370	0.370
1	0.780	0.210	0.120	0.340	0.040	0.380	0.120	0.340	0.200	0.330
0	0.0	0.770	0.0	0.550	0.0	0.250	0.0	0.180	0.010	0.110
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED NUMBER	1.26	0.25	2.26	0.58	2.91	1.25	2.74	1.54	2.41	1.75
STD. DEV.	0.52	0.48	0.83	0.75	0.97	0.98	1.20	1.10	1.11	1.14

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

SPACECRAFT TYPE : 2

PROBABILITY OF INDICATED LAUNCH ATTEMPTS

QUANTITY										
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.020	0.0	0.0	0.030	0.010	0.010	0.0	0.0	0.020
3	0.0	0.040	0.010	0.0	0.060	0.020	0.050	0.030	0.010	0.020
2	0.0	0.140	0.050	0.030	0.280	0.070	0.080	0.170	0.140	0.080
1	0.0	0.800	0.130	0.200	0.600	0.290	0.390	0.360	0.360	0.350
0	1.000	0.0	0.810	0.770	0.030	0.610	0.470	0.440	0.490	0.530
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED										
NUMBER	0.0	1.28	0.26	0.26	1.46	0.53	0.74	0.79	0.67	0.65
STD. DEV.	0.0	0.63	0.59	0.50	0.78	0.79	0.88	0.83	0.75	0.86

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

SPACECRAFT TYPE : 3

PROBABILITY OF INDICATED LAUNCH ATTEMPTS

QUANTITY										
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.010	0.0	0.010	0.0	0.0	0.0	0.010	0.0
4	0.0	0.0	0.070	0.0	0.040	0.0	0.040	0.0	0.0	0.0
3	0.0	0.0	0.210	0.0	0.060	0.0	0.020	0.040	0.040	0.040
2	0.0	0.0	0.760	0.010	0.800	0.180	0.490	0.370	0.350	0.220
1	0.0	0.0	0.0	0.130	0.090	0.370	0.360	0.350	0.410	0.460
0	1.000	1.000	0.0	0.860	0.0	0.450	0.070	0.290	0.160	0.160
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED NUMBER	0.0	0.0	2.43	0.15	2.08	0.73	1.58	1.11	1.34	1.22
STD. DEV.	0.0	0.0	0.80	0.35	0.63	0.75	0.81	0.87	0.86	0.78

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

SPACECRAFT TYPE : 4

PROBABILITY OF INDICATED LAUNCH ATTEMPTS

QUANTITY										
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
YEAR	1	2	3	4	5	6	7	8	9	10

EXPECTED NUMBER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STD. DEV.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

SPACECRAFT TYPE : 1

PROBABILITY OF INDICATED SPACECRAFT REQUIRED

QUANTITY										
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.030	0.0	0.0	0.0
5	0.0	0.0	0.020	0.0	0.020	0.0	0.020	0.0	0.010	0.010
4	0.0	0.0	0.070	0.010	0.150	0.010	0.140	0.040	0.050	0.020
3	0.040	0.0	0.180	0.0	0.470	0.100	0.320	0.100	0.320	0.110
2	0.180	0.020	0.610	0.080	0.320	0.230	0.370	0.330	0.400	0.380
1	0.780	0.210	0.120	0.360	0.040	0.410	0.120	0.350	0.210	0.370
0	0.0	0.770	0.0	0.550	0.0	0.250	0.0	0.180	0.010	0.110
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED NUMBER	1.26	0.25	2.26	0.56	2.79	1.21	2.66	1.47	2.22	1.59
STD. DEV.	0.52	0.48	0.83	0.73	0.82	0.96	1.11	1.07	0.90	0.96

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

SPACECRAFT TYPE : 2

PROBABILITY OF INDICATED SPACECRAFT REQUIRED

QUANTITY										
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.020	0.0	0.0	0.010	0.010	0.010	0.0	0.0	0.0
3	0.0	0.040	0.010	0.0	0.060	0.020	0.010	0.020	0.0	0.030
2	0.0	0.140	0.050	0.030	0.250	0.070	0.100	0.140	0.080	0.060
1	0.0	0.800	0.130	0.200	0.650	0.290	0.410	0.400	0.430	0.380
0	1.000	0.0	0.810	0.770	0.030	0.610	0.470	0.440	0.490	0.530
YEAR	1	2	3	4	5	6	7	8	9	10

EXPECTED NUMBER	0.0	1.28	0.26	0.26	1.37	0.53	0.68	0.74	0.59	0.59
STD. DEV.	0.0	0.63	0.59	0.50	0.69	0.79	0.77	0.77	0.63	0.74

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

SPACECRAFT TYPE : 3

PROBABILITY OF INDICATED SPACECRAFT REQUIRED

QUANTITY										
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.070	0.0	0.010	0.0	0.010	0.0	0.010	0.0
3	0.0	0.0	0.210	0.0	0.070	0.0	0.040	0.0	0.030	0.030
2	0.0	0.0	0.700	0.010	0.800	0.140	0.470	0.300	0.380	0.310
1	0.0	0.0	0.0	0.130	0.120	0.410	0.410	0.410	0.420	0.480
0	1.000	1.000	0.0	0.860	0.0	0.450	0.070	0.290	0.160	0.180
YEAR	1	2	3	4	5	6	7	8	9	10
EXPECTED NUMBER	0.0	0.0	2.43	0.15	1.97	0.69	1.51	1.01	1.31	1.19'
STD. DEV.	0.0	0.0	0.80	0.38	0.48	0.70	0.73	0.77	0.81	0.76

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

SPACECRAFT TYPE : 4

PROBABILITY OF INDICATED SPACECRAFT REQUIRED

QUANTITY										
11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
YEAR	1	2	3	4	5	6	7	8	9	10

EXPECTED										
NUMBER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
STD. DEV.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

ESTABLISHMENT AND MAINTENANCE
OF A SYSTEM OF EARTH ORBITING SPACECRAFT

PRESENT VALUE (MILLIONS OF DOLLARS)	PROBABILITY OF INDICATED PRESENT VALUE OF COST (DISCOUNT RATE=10.0)
1474.20-- 1493.43	0.010
1454.96-- 1474.20	0.0
1435.73-- 1454.96	0.0
1416.49-- 1435.73	0.010
1397.26-- 1416.49	0.010
1378.02-- 1397.26	0.030
1358.79-- 1378.02	0.010
1339.55-- 1358.79	0.010
1320.32-- 1339.55	0.0
1301.09-- 1320.32	0.050
1281.85-- 1301.09	0.040
1262.62-- 1281.85	0.060
1243.38-- 1262.62	0.070
1224.15-- 1243.38	0.070
1204.91-- 1224.15	0.060
1185.68-- 1204.91	0.120
1166.44-- 1185.68	0.130
1147.21-- 1166.44	0.070
1127.97-- 1147.21	0.040
1108.74-- 1127.97	0.050
1089.51-- 1108.74	0.040
1070.27-- 1089.51	0.050
1051.04-- 1070.27	0.020
1031.80-- 1051.04	0.0
1012.57-- 1031.80	0.050

EXPECTED PV 1202.05
STD.DEV. 92.38

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